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Engineering News-Record

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DECEMBER 14, 1933

TOWARD RECOVERY

¶ Nearly two million men have found jobs on Civil Works projects and more will soon be employed. The workers are earning fair wages through labor on useful betterments. This is real relief. Coming after months of ineffective efforts to get public works construction started, it testifies to the foresight and energy of the Civil Works Administration.

¶ But what the CWA is bringing about is only relief. It is not a step toward recovery. Civil Works lulls to sleep the self-reliance and initiative of local communities, and does little to restore life-giving flow in the channels of industry and business. Recovery cannot be attained in this way. As before it must be sought by driving, intensive prosecution of public works construction.

¶ The PWA movement is now slowly accumulating momentum. Within a few months its effects will begin to tell. Already, however, its resources are nearing exhaustion. Shall the work now come to an end? No! Congress undoubtedly will see that the fund is increased. But in doing so it should inject into its administration something of the speed now found in the Civil Works program, if the enlarged fund is to prove effective.

¶ These are the self-evident fundamentals of the new program: That it be sound, free of pork and from city pauperization; that all its operations shall be in useful and needed work in the public interest; that it bring into action the structure and machinery of industry and trade—for unless they be revived there can be no recovery; and, most important of all, that it be quick in action.

THE MODERN MAIN ROAD . . . *A review based on a countrywide survey*

FULLER-KINYON CEMENT PUMPS *on the two Greatest Bridges*

(Above) Mixing plant of the Healy-Tibbits Company, on the Oakland-San Francisco Bay Bridge. The pipe line of the portable Fuller-Kinyon Pumping System, which unloads box cars, is indicated by the arrow.

(Left) Plant of the Pacific Coast Aggregates Company, on the Marin side of the Golden Gate Bridge. Cement is unloaded from barges by a portable Fuller-Kinyon Pump, and conveyed to a 2000 barrel storage bin. The stationary pump below this bin conveys to two mixer bins, or to another 2000 barrel storage bin. The portable pump is also used for recovering cement from the second storage bin.

(Above) Plant of the Pacific Coast Aggregates, Inc., at the Fort Point side of the Golden Gate Bridge, showing one of the bulk cement barges.

(Below) View of the same plant. The portable Fuller-Kinyon Pump, which unloads barges, is connected to the flexible hose (1) and pipe line (2) leading to a storage bin over a stationary pump. The stationary pump conveys to the two large storage bins (3).

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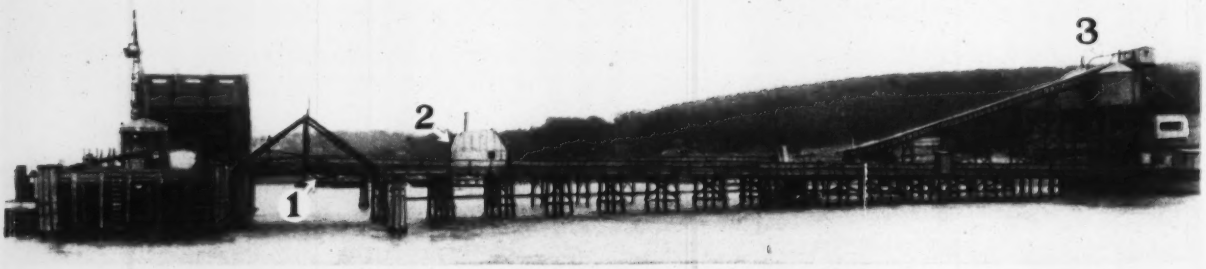

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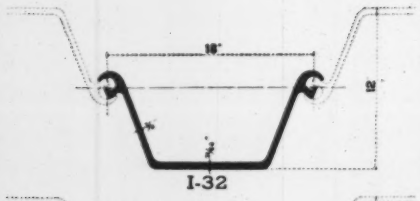

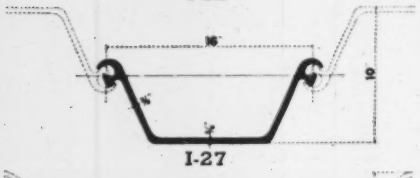

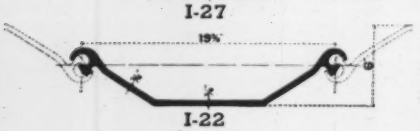

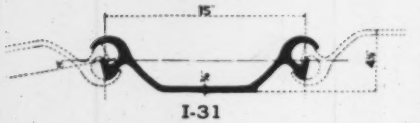

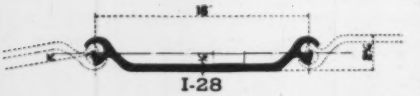

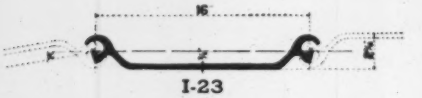

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Weight per foot	42.7 lbs.	36.0 lbs.	36.0 lbs.
Weight per square foot of wall	32.0 lbs.	27.0 lbs.	22.0 lbs.
Moment of inertia	87.0 in.⁴	53.0 in.⁴	22.4 in.⁴
Section Modulus	20.4 in.³	14.3 in.³	8.8 in.³
Section Modulus per lineal foot of wall	15.3 in.³	10.7 in.³	5.4 in.³
Section Modulus per foot interlocked	24.5 in.³		
Strength of interlock per lineal inch in direct tension	8,000 lbs.	8,000 lbs.	8,000 lbs.

Section	I-31	I-28	I-23	I-21
Weight per foot	38.8 lbs.	37.3 lbs.	30.7 lbs.	14.9 lbs.
Weight per square foot of wall	31.0 lbs.	28.0 lbs.	23.0 lbs.	21.0 lbs.
Moment of inertia	17.9 in.⁴	6.0 in.⁴	5.5 in.⁴	1.0 in.⁴
Section Modulus	8.1 in.³	3.3 in.³	3.2 in.³	1.0 in.³
Section Modulus per lineal foot of wall	6.5 in.³	2.5 in.³	2.4 in.³	1.4 in.³
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Engineering News-Record

New York

December 14, 1933

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Sanitary Improvement Program Solves Pollution Problem

Preliminary treatment plant at Findlay, Ohio, provides for subsequent additions to care for secondary treatment—Sewer rental, based on water consumption, pays for operation

By T. B. Henry
H. P. Jones & Company, Consulting Engineers, Toledo, Ohio

A COMBINED project of river-straightening and an intercepting-sewer and sewage-plant construction has recently been completed in Findlay, Ohio. The plant was designed to clear up the polluted condition of the Blanchard River, into which the city's untreated sewage has been discharged for years. It is being operated with funds from sewer rentals.

Featured in the design of the intercepting system are float-controlled stormwater regulators, a bypass control chamber which permits diversion directly into the river during flood stages, and the straightening of the Blanchard River channel past the sewage-plant site. A low dam in the river simplified the design of the interceptors, as the existing sewers discharged below the dam. Sewage flows are extraordinarily high due to a great amount of groundwater infiltration. Due to the financial limitations, the present plant was built to accomplish primary treatment only, but provision has been made for subsequent secondary treatment by the activated-sludge process. In the treatment works there are the following units: an incinerator that can be either oil- or gas-fired, three automatically controlled horizontal sewage pumps, chlorine equipment for odor control, a concrete heated digestion tank and glass-covered sludge beds.

The Blanchard River, which runs through the city, drains an area above Findlay of about 340 square miles. A large proportion of the area is tapped with impervious clay, and this condition brings about rapid concentrations of precipitation and high rates of flow in the river after rain storms. Conversely, in dry seasons there is only a low sluggish flow. Records of streamflow indicate that for periods of two to nine

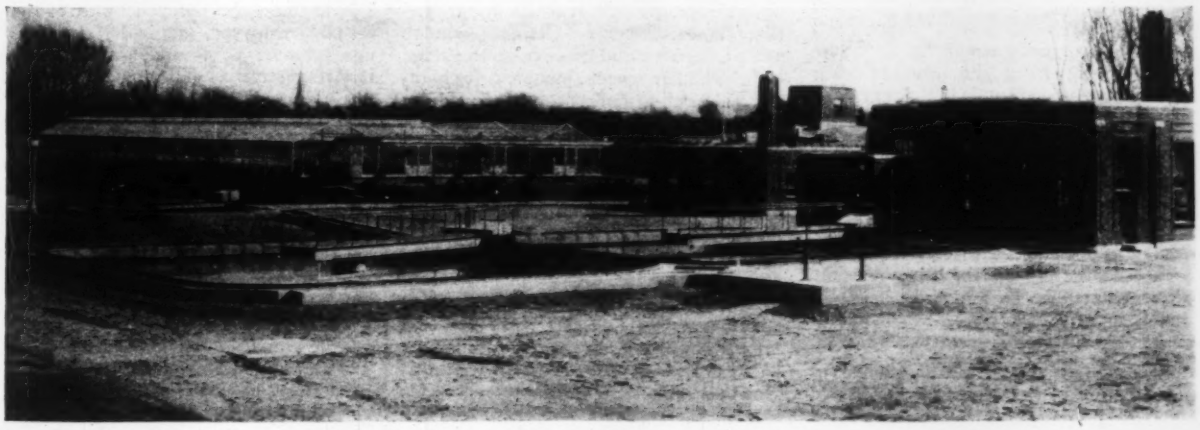


Fig. 1—General view of the Findlay, Ohio, sewage-treatment plant. In the foreground are the two settling tanks, with sludge-removal equipment in service. In the background are the glass-covered sludge-drying beds and the grit chamber. The earth-covered digestion tank, surmounted by a small building, can be seen over the roof of the garage building at the right.

months in each year the average daily flow is insufficient to provide sufficient dilution for disposal of sewage without treatment.

Existing sewers have been built almost entirely on the combined plan. Outfalls are located at mean river elevation and are thus subject to overflow and backing up in their lower portions at time of high water. It was impossible to design economical works to provide for the interception of the dry-weather flow at all stages of the river, so after a study of conditions it was decided to provide means for bypassing the treatment plant and allowing the flow to go directly into the river when the water level rises to El. 759.3, at which stage the river discharges 1,400 sec.-ft., an ample quantity to provide satisfactory dilution.

Interceptors

Under the plan adopted, an intercepting sewer system has been built which collects the dry-weather flow from the combined system and carries it to the treatment-plant site. Diversion weirs have been built in the sewers, with connections to the interceptors. In two cases, where the connections required were of comparatively large size, storm-water regulators with float-controlled shut-off gates were provided.

A low dam in the river holds back water in times of low flow to provide cooling water for the local power company. This dam raises the water levels 6 to 8 ft. through a part of the city, and as a consequence the sewers for the most part had been built to discharge at least the dry-weather flow below the dam. Such an arrangement simplified the design of the new interceptors by reducing the lengths of line required. As finally constructed, it was necessary to provide diversion facilities at only nine points to divert all the dry-weather flow into the interceptors

The interceptors are circular sewers, ranging in diameter from 15 to 36 in. A 42-in. bypass into the river was built, with control chamber in the dike surrounding the treatment-plant site. Sluice gates allow the sewage to be diverted into the river when the water level reaches the proper stage.

The sewage-plant site is a low-lying area formerly surrounded on three sides by a U-shaped bend in the river. As a part of the improvement program the river channel was straightened by eliminating the bend. This improved the river bed and made the site more easily accessible. For protection against floodwaters, the plant is entirely surrounded by a dike, the top of which is above the highest flood level of record.

Basis of design

Findlay is a city of 19,000 people. An examination of past census records and of factors influencing growth indicated that it would be reasonable to assume

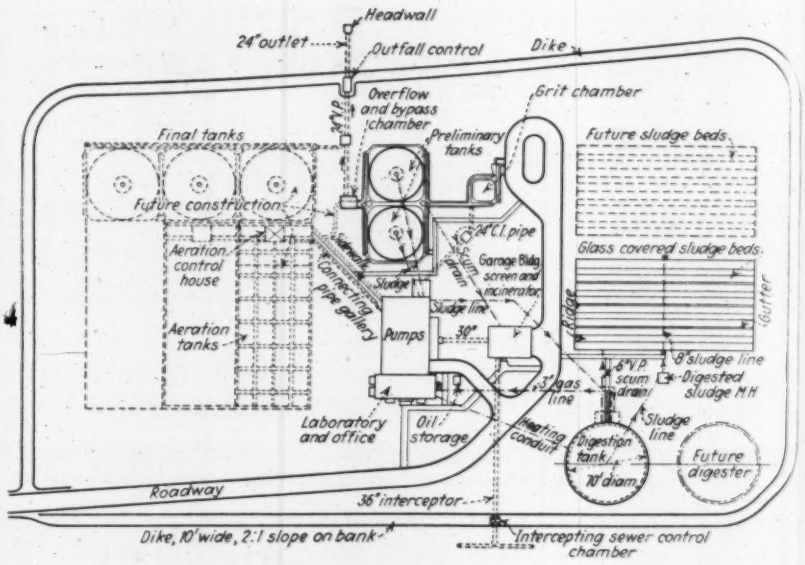


Fig. 2—Findlay sewage-works consists of preliminary settling tanks, digestion tank, incinerator for screenings and grit, and sludge bed with glassover.

that the population in 1960 would approximate 35,000 people. Determination of sewage flows to be expected was made by gaging and estimates. The necessary allowance for groundwater infiltration brought the figures for average and maximum flows to higher values than would ordinarily be expected.

The following estimated populations and sewage flows by decades to 1960 were used as the basis of design.

Year	Population	Flow in M.G.D. Aver.	Max.
1932	19,000	3.5	7.0
1940	25,000	4.0	8.0
1950	30,000	4.5	9.0
1960	35,000	5.0	10.0

Pretreatment only

The present installation provides preliminary treatment only, by means of plain sedimentation and separate sludge digestion. The units of the plant are as follows: bar screen, screenings incinerator, sewage pumping station, chlorine equipment, grit-removal chamber, settling tanks, overflow chamber, sludge pumps, digester and glass-covered sludge beds. The bar screen, pumps, grit chamber and settling tanks were designed for 1960 requirements, and the digester and sludge beds were designed to serve until 1940, when they will have to be supplemented by duplicate units.

Secondary treatment in the future by the activated-sludge process has been planned for. Plans were drawn for the first aeration unit, designed to take care of the present population. Bids were taken on these secondary works under a separate schedule at the same time that bids were received for the primary units. However, financial considerations made it advisable to defer construction of the secondary works until a later date.

The bar screen and the screenings incinerator are housed in the garage building. The screen is 6 ft. wide and is made up of $\frac{3}{8}$x3-in. bars, 9 ft. long, set at an angle of 45 deg., with $\frac{3}{4}$-in. openings. It is manually cleaned. Screenings are loaded into metal buckets and hoisted 10 ft. by means of a small monorail crane to the incinerator floor. The incinerator has a capacity of 48 cu.ft. per day. It is arranged to use either gas or oil for fuel, the intention being to use excess gas from the digester in normal operation.

From the screen the sewage flows to a pump-suction well in the main building. Here also are grouped all the pumps and meters for handling sewage and sludge, boilers for heating the plant and the digestion tank, circulating pumps, transformers and switchboard. Provision has also been made for the future installation of air-filter equipment, blowers and return-sludge pumps for secondary treatment. In the superstructure of this building are the office, laboratory, toilet and locker rooms and the chlorine room.

The sewage is pumped by three horizontal, trash-type, motor-driven centrifugal pumps, 3-, 4- and 5-m.g.d. capacity, respectively. They operate against an average total head of 22 ft. The operation of the pumps is controlled by a float-operated selector switch, which starts and stops the pumps in proper order or combination as the rate of sewage flow rises and falls. The pumps may also be operated by independent controls if necessary. An automatic vacuum-priming system includes two motor-driven vacuum pumps, each with a capacity of 15 cu.ft. of free air per minute at a 20-in. vacuum. The vacuum system keeps the pumps continually primed for instant use.

The pumps deliver the sewage through a 24x14-in. venturi meter to the

grit chamber. Just beyond the meter provision is made for the introduction of chlorine through two machines of the solution type, each with a capacity of 350 lb. per day, providing for a maximum treatment of 15 p.p.m. for a 5-m.g.d. flow. Chlorine will be used for odor control only. No provision is made for sterilizing the final effluent. The grit chamber is a 20 ft.-square, mechanically cleaned tank, equipped with a grit-washing device of the mechanical-rake type. The rake discharges the cleaned grit on a platform, from which it is loaded into a truck and hauled away to be used for fill. The detention period through the chamber at maximum flow is ½ minute. A stop gate permits bypassing the grit chamber and turning the sewage directly into the settling tanks whenever desired.

From the grit chamber the sewage flows to the settling tanks. These tanks are two in number, 50 ft. square with 10½-ft. total and 9-ft. effective side depths. They are designed to give a detention period of 1½ hours at a 5-m.g.d. flow. Mechanical cleaning equipment of the traction-driven type concentrates the sludge in a cone at the center of the tank bottom. The effluent from the settling tanks flows first through an overflow and bypass chamber and thence through the outfall control chamber to the river. The overflow and bypass chamber will serve, by means of an adjustable weir and gates, when secondary treatment is installed, to control the flow to the secondary units and to limit the flow to any desired amount. The outfall control chamber houses a sluice gate and a flap valve, which prevent flooding of the plant during high water in the river.

Digestion tank

Sludge is pumped from the settling tanks to the digester by means of two 4-in. motor-driven plunger pumps. One is a 50-g.p.m. simplex unit and the other a 100-g.p.m. duplex. This equipment is located on the pump-room floor of the main building.

The digester is a circular tank, 70 ft. in diameter, with 19½-ft. side-water depth. It is equipped with an agitating mechanism that revolves two sets of blades, or arms, attached to a central vertical shaft. One set is located at the top of the tank to break up the scum, and the second is located at the bottom and serves to thicken the sludge and push it toward the outlet at the center. The top of the tank, upon which the mechanism and the housing is supported, is a reinforced-concrete dome, 70 ft. in span with a rise of 6 ft. 9 in. The thrust from the dome is taken at the side walls by 36 1-in. steel rods, prestressed by means of turnbuckles embedded in concrete. The sides of the tank are banked up with earth, and the top slab in insulated with a layer of 12-in. building tile embedded in cinders over which is a layer of earth varying from 9 in. in depth at the center to 3 ft. at the side.

The tank is heated by hot water flowing through four turns of 2½ in. pipe hung on the side walls. The water-heating system is located in the boiler room of the main building. Two boilers are provided to generate steam for heating the digester and the buildings. One is gas-fired, and the other is equipped for both gas and oil. Steam from either boiler is used in a heater to raise the temperature of the water to heat the digester. The hot water is circulated by means of two small motor-driven centrifugal pumps also located in the boiler room.

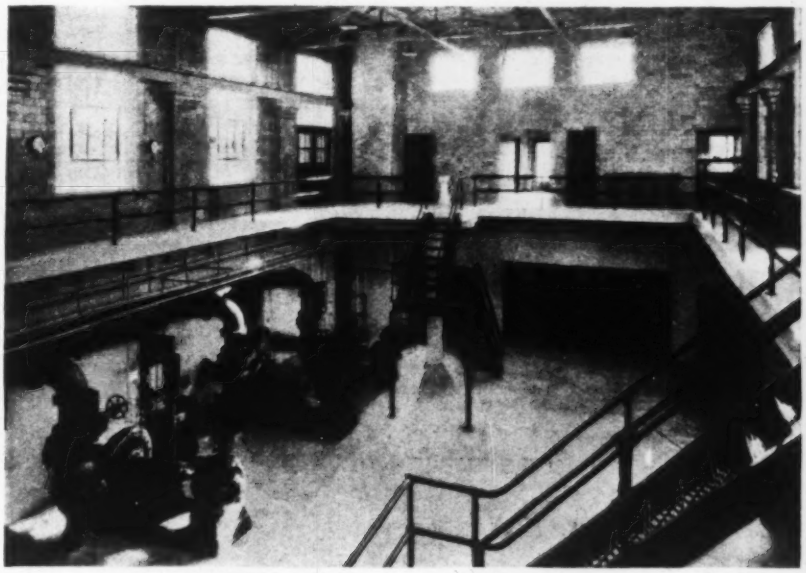


Fig. 3—Three automatically controlled centrifugal pumps lift the screened sewage to the grit chamber. Space has been left in the pump room for a future installation of blowers.

Sludge glassover

Digested sludge is drawn by gravity from the digester to the sludge-drying beds. The beds are glass-covered and have an area of 12,500 sq.ft., or 0.5 sq.ft. per capita for 25,000 population. Four beds are provided, each 20 ft. wide and 157 ft. long. An overhead monorail track, carrying a 25-cu.ft. side-dump bucket, runs over the center of each bed for transporting the dried sludge outside, where it may be dumped directly into trucks.

Careful attention was given to obtain a pleasing appearance both outside and inside the buildings. The grouping and architectural treatment of the buildings and the neat finishing of the concrete structures contribute to an attractive layout. Superstructure exteriors are of rough-textured brick in two tones of red, finished with cut-stone copings. The interior walls are made of buff colored glazed brick tile, presenting an attractive and easily cleaned surface.

Financing

Construction costs of the project totaled $306,000, divided as follows: interceptors $108,000, treatment plant $198,000. The work was paid for out of the proceeds of the sale of general obligation bonds.

To provide funds for operation, a sewer-rental ordinance was set up. Charges are made on the basis of water consumption, and the two services, water and sewage treatment, are billed together. The rates charged for sewage-treatment operation are as follows:

$0.20 per month minimum for 300 cu.ft. or less.
0.04 per 100 cu.ft. for next 1,700 cu.ft.
0.03 per 100 cu.ft. for next 2,500 cu.ft.
0.02 per 100 cu.ft. for next 3,500 cu.ft.
0.01 per 100 cu.ft. for all over 8,000 cu.ft.

Shutdowns since starting operation in January have been frequent, due to unusually high water, but the operating results have been highly satisfactory. No detailed records continuous over an appreciable period of time are yet available, but daily records indicate that the plant is operating efficiently. Gas is being produced in sufficient quantities to use under the boilers, and digestion was started without undue foaming troubles.

The operation of the plant is in charge of Ben Barton, as chief operator, under Otto C. Gohlke, city engineer, who is also superintendent of the sewer department. H. P. Jones and Company, engineers, of Toledo, Ohio, prepared the plans and supervised the construction of the interceptors and treatment plant. Frank George, of Youngstown, Ohio, was the contractor on the interceptors, and the A. Bentley & Sons Company, of Toledo, Ohio, were the contractors on the treatment plant.

Today's Perfected Main Road

Main-road engineering has developed from specialization in design and construction of surfacing to include replanning the fundamental elements of the road to permit its capacity to be expanded with increased traffic

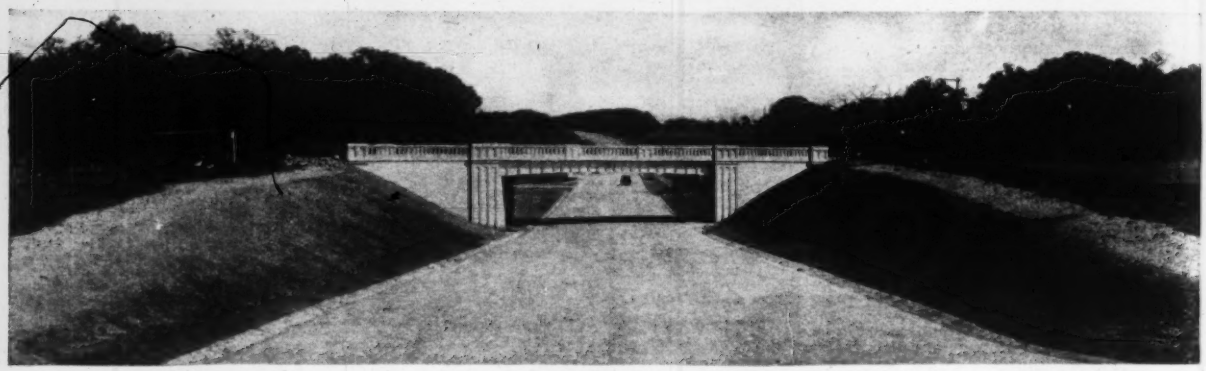
By Charles S. Hill
Associate Editor, Engineering News-Record

THE MAIN ROAD has passed through many phases. The modern phase began with the inventions of Macadam and Telford. These greatly improved road surface and structure but brought little change in the fundamental plan of the road. Similarly when waterbound macadam gave way to the more stable bituminous, brick and concrete surfaces, the line, grade and roadway elements remained substantially unchanged. But, with continued use of hard surfacing, change in the plan of the road began to emerge.

The new surfaces brought with them the elements of greater cost and greater permanency. Preservation of investment and the longer life period pointed logically to improved line, grade and roadway. A rapid increase in volume, weight and speed of traffic brought by the motor vehicle focused attention further on line and grade, as well as surface, as factors in traffic economy and safety. Then, as roads were improved, traffic grew to exceed their capacity, and the necessity of planning for roadway growth was forced upon the roadbuilder. Thus the main road entered a new development phase, that of improving the fundamental plan of the road as well as its surfacing.

Within a brief period the conception of road-engineering design as primarily a problem in surfacing has advanced to a conception of the road as a progressively developing structure, the growth of which must be prepared for in the fundamental elements of line, grade and roadway profile. This does not mean that design of surfacing is being disregarded. Instead, it is receiving at present the most study ever devoted to it, and the results of these studies are being introduced in practice more actively now than ever before.

Altogether the main road, as the road-building year of 1934 begins, represents quite different engineering objectives than it did a few years or even a year ago. It is a better engineering structure and a better tool of transportation. What then is the modern main road? It obviously is not any traveled way that has main-road functions because these ways differ widely. Similarly it is not the superhighway. Rather it is the representation in design and construction of the road engineers' conception of the practicable, ideal, general-service thoroughfare for main-road travel.



Refinement in highway grade-separation characterizes the perfected main road, as shown by this prairie state example of a two-lane crossing.

The individual main road rarely expresses this distinction in all its elements. In the following discussion, elements from many modern main roads have therefore been selected to present a practicable ideal of modern main-road practice. Also trends and general principles of practice are emphasized rather than details of structure or procedure. The sources of information have been reports of practice from virtually all states, interviews with state highway department engineers and personal inspection of main roads in many states.

Line and grade

LINE AND GRADE as considered here refer only to horizontal alignment and vertical profile. Except right-of-way, line and grade are the only road elements for which permanency can be insured in the original design. All other elements—roadbed, surfacing, ditches and slopes—can be given only limited life. In the modern main road, therefore, design is directed to line and grade that will be final. This may be stated as the first principle of practice. Compliance with it is diligently striven for in the best recent line and grade design.

Direct line and low grades are essentials. Their realization is ordinarily a task of rectification. The modern main road is fixed as to direction and general alignment because a road already exists, and there are few instances in which complete departure from an established travel thoroughfare is allowable or economically justified. The main reasons are (1) a real investment exists in the old road right-of-way, cuts and fills, roadbed materials and drainage structures, on which little can be realized if the road is abandoned; (2) the owners along the road have a vested right not to have the main road taken away from them; and (3) only exceptional traffic demands warrant investment in a completely new road.

Rectification of line and grade, however, is universally recognized in present practice as a basic element of modern main-road construction. Practice sets no standards. Each road is considered a separate problem, and the solution is individual to that road. System requirements enter into consideration, but they have relation more to the classification of roads for improvement than to the solution of the problem of the individual road line and grade. This problem involves *(a)* engineering economics and *(b)* safety of travel. Both are vital factors in rectification practice.

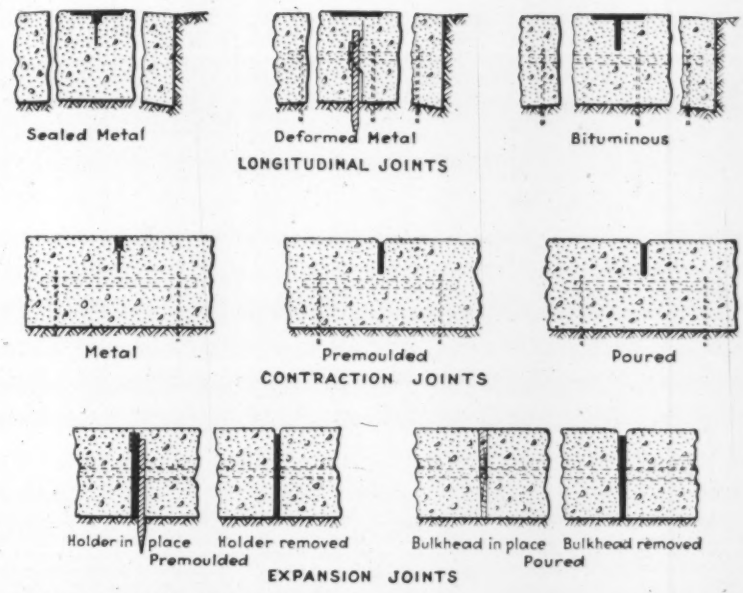
Disregarding details of technical solution, general procedure takes about the following lines.

Classification of the road as to its present and future traffic importance in the state and interstate road system is determined. This is the exercise of judgment based on careful traffic surveys and a careful appraisal of future tributary business development and consequent growth of through and local traffic. The traffic survey, being about the only source of quantitative facts, is regarded as highly important. Briefly, the first rule of rectification (making right) in practice is: Precede improvement by a thorough traffic survey and a classification of the route. With these determinations established, policies can be formulated for the individual road as to limitations of line and grade.

The first step is a survey of the existing road, and by "survey" is meant far more than an instrumental determination and mapping of line and grade. The survey required includes: *(a)* existing physical structures such as character of roadbed and surfacing, character and adequacy of culverts and bridges, character and number of intersections, entrances and railroad crossings; *(b)* construction conditions such as character of soil and prevalence of rock, amount of clearing and grubbing, existence of marsh areas and location and extent of materials available for construction; and *(c)* general engineering conditions such as stream crossings, topography as affecting widening, straightening and curve superelevation, and possibilities and expense of additional right-of-way for widening or new right-of-way for straightening, cutoffs and bypasses.

The foregoing may be regarded as the essentials of the survey for economic appraisal. The survey for travel safety and convenience carries the list of items to the determination of sharp, abruptly vertical, unwidened and unbanked curves, curves approaching bridges and underpasses, narrow bridges, blind crossings and intersections and short sight distances. In modern main-road practice the survey of danger points is given an importance scarcely subordinate to the survey of data for economic appraisal of warranted improvement.

Actual design of line and grade is controlled by the findings of these factual surveys. Keeping to modern main-road standards, a preliminary line and profile are laid down on the old route plats. The two lines and profiles are studied in the light of the survey data and a new line and grades are determined, holding as close as physical conditions and justified expenditures will allow to the ideal line and grades. The result is not line and profile that would be laid down with no old-route limitations; it is a compromise, but one that can ordinarily be brought remarkably close to the ideal. In general, while design shows latitude in particulars, it does no violence to basic principles. It



Types of joints used in concrete pavements and pavement bases for brick and bituminous surfaces.

is continually a surprise how moderate are the alterations needed to bring old roads into reasonable conformity with modern standards of line and profile. This is of course more particularly true of plains country than of mountain regions, where commonly old trails that have developed into roads require very important changes of line to satisfy modern design standards.

In thinking of line and grade standards for the modern main road, there should be no picture of close definition. Rational design of these elements is not attainable with the present fragmentary balance sheets of the highway as a tool of transportation. Considerable has been done to fill the gap in respect to the bearing of line and grade on vehicle operating costs, and this knowledge is widely applied in present-day design. But mainly line and grade design is the application of originality and engineering judgment in fitting a plan to meet an individual situation without violating recognized fundamental principles.

In alignment, directness and safety are words that epitomize the fundamental principles. This is not a text for determining values of line shortening, but it is obvious that directness of line has a value in reduced vehicle mileage and reduced mileage to be constructed and maintained. It has as plainly a safety value because of curve reduction and extended sight distances. In line design, modern main-road practice regularly seeks directness and safety by cutoffs to eliminate kinks and bends, bypasses to avoid towns and cities, relocations to avoid railway crossings and straightening of bridge and underpass approaches. Shortening of line ordinarily is so bound up with grades and safety that its value in time and cost saving to vehicle operators is a pretty uncertain estimate; in various states such savings are estimated at from 5 to 8c. a vehicle-mile.

The principles governing curve alignment in modern road practice are to keep the curve as nearly as possible flat enough so that no reduction of vehicle speed is necessary in rounding it, and where sharper curves have to be used to introduce adequate superelevation, and in vertical curves to adopt such flattening as will afford adequate sight distance for safety. In general, a 3-deg. curve is considered to be as sharp as is safe without superelevation, and 500 ft. is thought to be the minimum sight distance on vertical curves at crests. The modern main road rarely violates these principles.

The practices governing the degree of superelevation and the amount of widening are considered under roadway profile. In curve alignment, past highway practice has commonly disregarded transition spiraling or easement. This refinement of curve development is receiving more definite consideration in current main-road location.

The design of economic grades is a complex problem whether for rectifying existing road profile or for new location. In modern main-road practice the outstanding advance is definite direction of design to ensure economical transportation service rather than the utmost economy in construction. This involves as essentials the determination of characteristics of traffic and the analysis of grade influence on vehicle-operating costs. Traffic surveys and recent experimentation on vehicle-operating efficiency and cost are furnishing much fundamental information that is being consistently utilized. The technical procedure is not a part of this discussion, but attention to vehicle-operating economics is bringing into consideration in highway-grade design questions of

ruling grade, compensating grade, momentum effects, vehicle resistances and other influences long considered in railway-grade design.

While these advances are distinctly recognizable in modern highway-grade design practice, they have yet an element of tentativeness. Characteristics of traffic on highways are rather indeterminable. Automobile traffic is preponderant without question, but business-vehicle traffic is developing; what grade modification may be justified to serve bus and heavy truck and trailer-train traffic is a real question. Nor can construction costs of cutting down grades or costs of lengthening line to avoid grades be minimized as still important factors in grade design. Withal, the fact remains, however, that modern grade design is recognizing more distinctly the economy of transportation service as a controlling factor.

In this summary of modern road line and grade design, surveying and computing procedures have been given no place; they are various and are all within common engineering knowledge and capacity. To summarize briefly, the fundamental findings are: (1) Traffic surveys and classification of road are the first step in planning. (2) Directness and safety are the controlling factors of line location. (3) Line and grade design, showing latitude in particular, keeps close to basic general principles. (4) Superelevation and easement are essential elements of curve location. (5) Grade design is directed increasingly toward economics of transportation service. (6) All line and grade planning has to be adapted largely to topographical and financial conditions.

Roadway profile

ROADWAY PROFILE shows the most marked change of any of the elements of the modern main road. As considered here, roadway embraces all dimensions and structures between right-of-way boundaries, except pavement, bridges and culverts. Its modern characteristics are distinctively a much greater width and more gentle profile of cross-section for normal run of road, with special expansion of these elements on curves and fills and at intersections, entrances and railroad crossings.

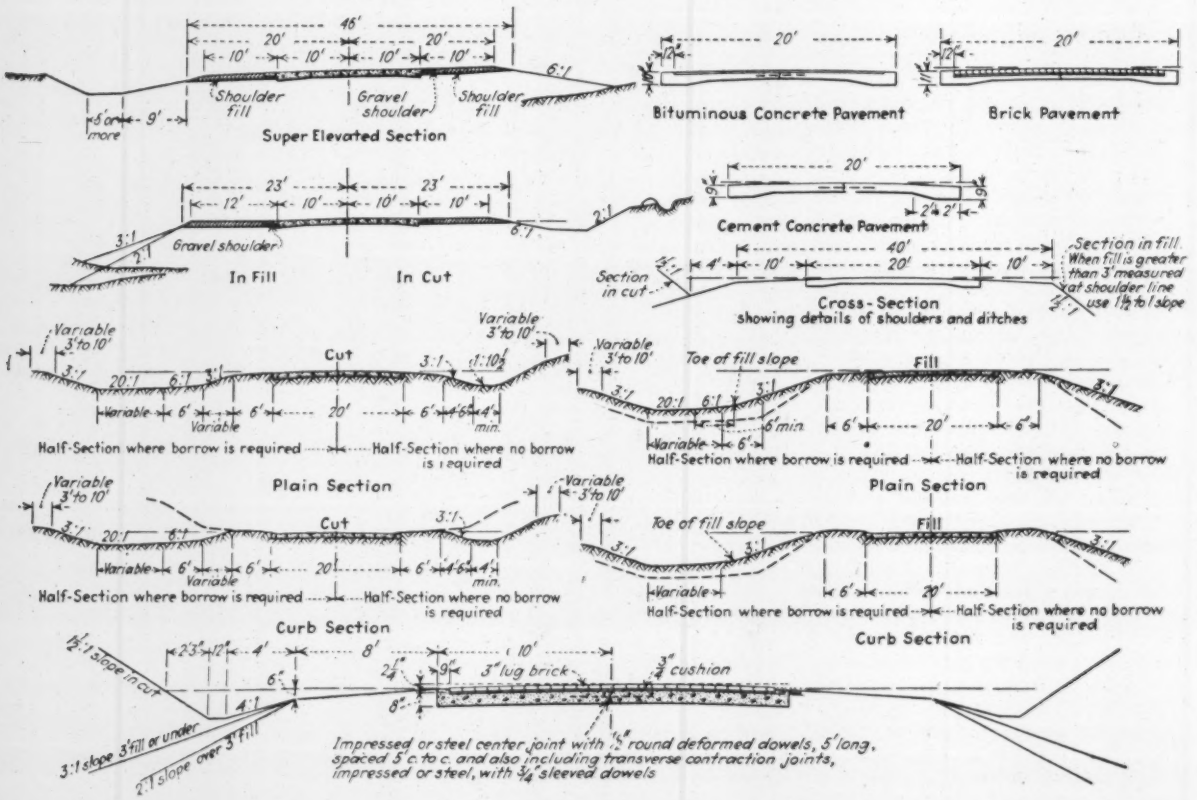
The modern right-of-way is wide. The old four-rod strip between farm fences no longer has a recognized place in the make-up of the main road. An 80-ft. right-of-way is the minimum accepted other than by compulsion; a 100-ft. right-of-way is commonly sought; and at intersections, road entrances and approaches to cities a 125-ft. and wider right-of-way is held essential. These widths are based on the theory that the main road is a laterally expanding structure and that the right-of-way is the only provision for expansion that may be fixed permanently at the beginning. But while the wide right-of-way is primarily to permit roadway expansion, it permits a cross-section of gentle slopes that contribute to safety and to ease of maintenance.

Definition of current practice in cross-sectional profile is given by the accompanying illustrations. Two distinctive features are the smoothly rolling across-road profile and the width of roadbed between inner slopes and ditches. Virtually, the graded roadbed of the two-line paved road gives an additional stabilized-earth travel lane on each shoulder and provides, when travel warrants it, for expansion of the paved-road width to three or four lanes. As safety measures, the wide, gently-sloping shoulders have obvious efficiency that is reinforced by the flat ditch cross-sections and side slopes of cuts and fills. These slopes of 1 on 3, or flatter, almost permit of safe driving anywhere on the cross-section except at the deeper cuts and fills.

The advantages of wide and gently rolling cross-section to the maintenance engineer are plain. Protection from the removal of snow are easier tasks; in cuts particularly there is increased room for side-of-road snow disposal. The gentle slopes reduce speed of runoff and can be planted to cut down wind drift and erosion by rainfall. Machine grading and mowing can keep ditches dressed and clear of weeds. While greater widths have to be kept in order, this added area is compensated for by the increased spread and speed of machine operations.

Normal run-of-road cross-section, which has been so far considered, is commonly modified by increased width

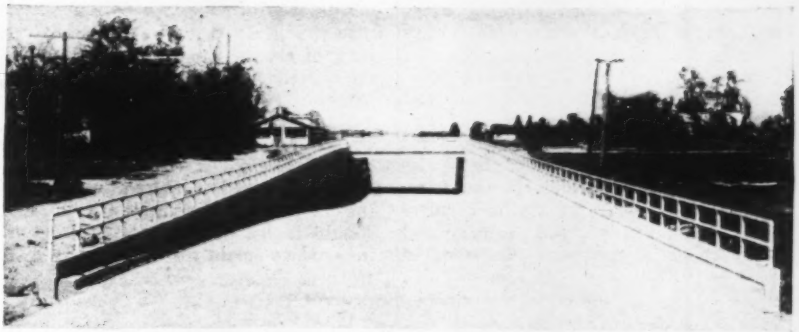
Pavement and roadway sections display the flat slopes and rolling profiles that characterize today's main road.


Super Elevated Section
Shoulder fill
Gravel shoulder
Shoulder fill
Bituminous Concrete Pavement
Brick Pavement
In Fill
In Cut
Gravel shoulder
Cement Concrete Pavement
Cross-Section showing details of shoulders and ditches
Section in fill. When fill is greater than 3' measured at shoulder line use 1½ to 1 slope
Section in cut
Cut
Fill
Toe of fill slope
Half-Section where borrow is required
Half-Section where no borrow is required
Plain Section
Curb Section
3" lug brick
¾" cushion
Impressed or steel center joint with ½" round deformed dowels, 5' long, spaced 5' c. to c. and also including transverse contraction joints, impressed or steel, with ¾" sleeved dowels
½:1 slope in cut
3:1 slope 3' fill or under
2:1 slope over 3' fill

on curves and high fills and at intersections and approaches. At curves the roadbed is graded to superelevation and widened by an amount corresponding to the degree of the curve. Practice is not at all uniform, but extra roadbed widths run from 2 to 8 ft. and superelevations from ½ to 1 in. per foot width, depending on pavement design practice. The roadbed grading on curves in respect to widening and superelevation is merely the fitting of the foundation to the anticipated superstructure of pavement.

This is similarly the situation at intersections and approaches, but here requirements for storing and redistributing interrupted traffic streams introduce other needs for grade widening beyond the normal.

Design of roadway for the modern main road involves, first, wide right-of-way and, second, utilizing that right-of-way to develop a cross-section with a smoother profile and wider roadbed, ditches, cut and fill slopes and roadside development zones. Both have definite objectives: (1) The capacity of the road can be expanded by adding to what has been constructed without tearing down existing structure. (2) Increased width and smoother cross-section make a safer road for travel and one that can be more perfectly maintained. (3) Planting and roadside development can be undertaken without the hazard of being sacrificed when the capacity of the road has to be increased.



Above: Underpass type of grade-separation at road intersection in plains country.

Below: Wide roadway and typical smoothly dressed and rounded cut slope.

Design of roadside

IN THE modern main road, appearance is as definitely an objective of roadway design as are utility and safety. As it involves other considerations than service and safety of traffic, it is discussed separately. Esthetics, an objective rather jibed at by practical roadbuilders for a long time, enters design thinking.

But "esthetics" does not express fully the thought controlling roadside design. A conception of utilization value as well as of esthetic pleasure is involved. Roadside planting, for example, is planned with a definite purpose of holding slopes, reducing erosion and lessening snow drift, in addition to beautifying the roadside.

Roadside design from this viewpoint begins with wide right-of-way. The smoothly rolling across-road profile, which wide right-of-way makes possible, has esthetic value in itself. Besides, the gently curving planes are particularly favorable to planting and to the equally important task of keeping the growing vegetation neat and trim. Maintenance, in brief, is an essential element in the preservation of attractive roadsides, and, as stated, flat even slope planes encourage close maintenance by making it less difficult and expensive. Specific directions for planting are not a part of this consideration. The trend in roadside design, however, is directly toward simplicity.

Elaborate landscaping and flowerbedding, except at show intersections or parkway approaches to towns, are regarded as neither a logical art nor a warranted expense. Tight hold is kept generally of the theory of the road as primarily a utilitarian development in which ugliness is to be shunned and attractiveness sought, but not by plastering the roadside with the horticulturist's inventions.

Roadside design, therefore, is the smoothing of the run-of-road sectional profile and also of the irregular spare plots of land at intersections and rounded corners and the planting of both with vegetation natural to the soil and vicinity and particularly with native grasses. This vegetation best holds the slopes from sloughing, gullying and erosion, is easiest kept trim and neat and fits perfectly into the off-road growths along the way.

It has been plainly indicated but should be emphasized further that a major consideration of roadway design, including roadside, is the maintenance of designed slopes. This is the function of planting, as much as is the covering of raw soil left by grading operations, with growths pleasing to the eye.

A second truth to be grasped from modern main-road practice is that if appearance of roadside is to be increased effectively, it is necessary that there shall be an attractive fundamental roadway design. This quality is given by the wide right-of-way that enables freedom in adopting a sectional profile of smooth-rolling curves and end planes.

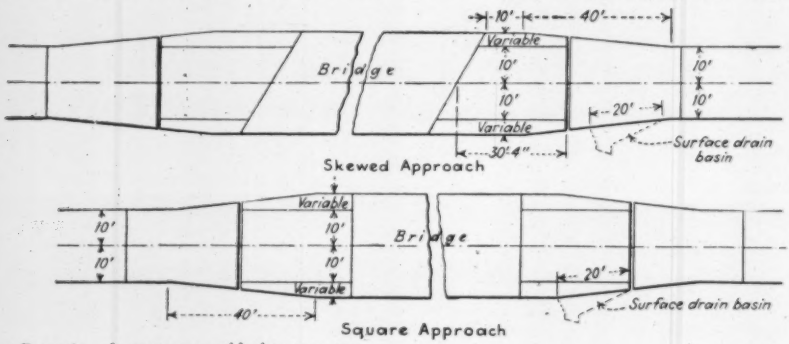
Shoulder and sub-base

ATTENTION to stabilized subgrades and shoulders is pronounced in modern main-road practice. Studies in soil stabilization have proceeded far in a few years in the laboratories of the Bureau of Public Roads and through laboratory and field work by state highway departments, colleges and manufacturers. As a result, knowledge of soil physics and means of testing soil constitution, as it determines suitability for pavement foundation and traffic wear, are practical working tools in the hands of the advanced roadbuilder. Roadbuilders too are using these tools with constantly increasing effectiveness.

Subgrade stabilization has taken two general directions, fixating the natural soil by admixtures and replacing the unstable soil by one that is stable. As practiced, the two methods are not always clearly distinctive. In general, soil replacement is more common practice, but rarely does it reach the magnitude of considerable removal of the unstable material. It more ordinarily consists in dressing the unstable soil with one that is stable, which by sealing and surface combination forms a stabilized crust. Combined with special provisions for drainage, this is the usual method of stabilizing subgrade; it is replacement having an element of true stabilization.

True soil stabilization is a process of

physical reconstruction. Virtually every soil has some of the elements, either friction elements or cohesive elements, that make a stable soil. Stabilization is the process of determining by analysis the elements of the natural soil, calculating the additional elements needed for stabilization and supplying these elements by admixture and incorporation. Control of moisture is a vital requirement in stabilization, and drainage and often chemical treatment are parts of the process. Generally true stabilization has been less used than has soil replacement, but it is growing in favor as the technical procedure is simplified and confidence in its practicability is established.



Example of pavement widening on approaches to bridges.

In advanced main-road practice, grading of roadbed as it involves creation of suitable foundation for pavement is preceded by a soil survey. This may be a new determination of soil data by a field survey or an examination and appraisal of data from existing knowledge of soil character and behavior obtained by experience with the present road. In no case is work undertaken lacking some, and generally rather complete, soil data.

Width and slope have been mentioned as elements of shoulder design. Design of shoulders for traffic wear is equally outstanding in advanced main-road practice. The wide flat shoulder is conceived as a supplemental traffic way and not merely as a margin of width for safety and an abutment for the pavement edge. Travel uses the wide shoulder as a parking zone and more importantly as a lane for farm-team and tractor service. As a travel lane, stability and surface become necessary shoulder elements. The modern main-road shoulder construction is therefore low-type road surfacing, either stabilized earth or bitumen-treated sand or gravel. This construction has a secondary value in cutting down dust and wash.

Intersections and crossings

THE INTERSECTIONS of roads and road crossings of railways are emphasized parts of modern main-road planning. Consideration of them begins in establishing right-of-way, line and grade to avoid crossing, give directness of approach, increase sight distance and provide space for vehicle maneuvering. It extends to the planning of special intersection layouts and underpasses and bridges to separate grades. The extent of the crossing development is determined by integrating traffic intensity and topographic conditions.

The most perfect intersection or crossing is the grade-separation, and it is sought to the utmost practicable extent in modern main-road planning. The problem is structurally the simpler for road crossings of railways as it involves no structures for traffic interchange. Limitation of railway grade alteration, however, often makes road-rail separation the more costly. The modern main-road railway-grade separation shows advance over conventional types of the past chiefly in more attractive and permanent structure; wider roadway for road traffic; straighter approach line and easier grades, and a smother roadway profile.

Distinct development is shown by modern main-road intersection practice. Considering the main road as a two-lane paved road, the functions of an intersection are to provide for an interchange of traffic between the two roads and to provide for the crossing of four streams of traffic. The relative demands on these two functions vary at every intersection. One requirement may predominate and the other be very small, or the two may be equal, or dominance may pass from one to the other as traffic develops. The possible permutations and combinations are many and the number does not remain constant. Standards of design and construction are therefore not contemplated in practice. In a broad way, types or classes of intersections have been recognized and tentative design principles have been accepted.

General classes are (1) Intersections at grade where interchange of traffic is small and provision for crossing traffic is the main objective. The common practice is to plan the approach roads to form a crossing plaza; with signals this type of intersection will pass safely a heavy traffic. (2) Intersections at grade where interchange of traffic is an important objective as well as traffic cross-movement. The circle intersection is the common form; its effectiveness is greatest when more than two roads intersect. (3) An intersection with grade separation and interconnecting ramps for exchange of traffic. These intersections have many forms and degrees of complexity; generally too they are essentially heavy-traffic types and find place most often on roads of more than two lanes.

Inspection of advanced intersection practice discloses the facts that each intersection is a separate problem requiring an individual solution; that planning involves a careful analysis of present and future traffic; and that the plan must interpret and express the distinct purpose of the traffic. Rules of design that are generally expressed are: (1) Extra leeway for maneuvering should be provided at the point of meeting of traffic streams; flaring, widening and corner rounding provide an approximation to a plaza-like space. (2) All turns should be arranged to be in the direction of traffic. Where there must be crossing of traffic streams it is arranged to be accomplished in some distance unless the traffic streams are light in volume. (3) The physical layout should tend to induce proper traffic direction. Examples of the application of this principle are the use of islands and local widenings. By the skillful use of these devices traffic may be induced almost unconsciously to take proper routes in traversing the intersection. (4) Signs should plainly indicate the proper traffic movements, and the intersection should be lighted so that these movements may not be hampered by poor visibility.

Concrete pavement

THE BROAD CHARACTERISTIC of modern main-road concrete pavement design is that basic standard requirements are better understood and are more purposefully provided. Both rational calculation and empirical rules are employed. These are given different relative importance and are themselves different in different states. All practice involves considerations of load, of temperature and moisture effects on concrete and of the influence of subgrade support on slab stability. In general, design procedure includes, first, conversion of moving traffic loads into equivalent static load on which design should be based; second, determination of the probable modulus of rupture of the concrete from which the safe working strength can be calculated; and third, based on knowledge of the critical load of prevailing traffic, decision on slab cross-section.

Formulas and methods of computation are not a part of this discussion. Two facts are to be noted, however: First, research and mathematical analysis in recent years have provided designers plentifully with design data and tools for computation and are constantly being added to and perfected. Second, no such thing as a standard design

method or a standard design exists for all states. In fact, there is no single detail in which the practice in all states is in complete agreement. There are, however, widespread practices and basic features which have been adopted in a large proportion of the designs for concrete paving for main roads, and these are briefly reviewed.

Width—Recent examples of main-road pavement show none with fewer than two traffic lanes and few with a traffic lane width less than 10 ft. The modern main road has a 20-ft. pavement, and this holds whether the pavement is concrete, brick or of a bituminous type. With modern bus and motor-truck-trailer traffic and with present high automobile speeds a pavement of two 10-ft. lanes is considered the minimum width for free traffic movement. Widening of the pavement is universal on curves and at intersections and approaches. On curves the extra width ranges from 2 to 8 ft., depending on the degree of the curve. At intersections the widening, determined by traffic, ranges from a moderate splaying out of the pavement into gentle approach curves to the addition of two extra side lanes for some distance approaching the intersection. On busy roads the four-lane intersection materially increases the number of vehicles that can start for a quick getaway when opposing cross-traffic opens a way.

Cross-section—The modern main-road concrete pavement is of distinctly heavy cross-section. Most generally too it is of thickened-edge section, but a number of states having the best design traditions deny the merits of edge thickening and employ uniform-depth pavement. Whatever the slab type, however, the section, while varying with subgrade and traffic conditions, is a sturdy one. The average edge thickness is well over 9 in. and the average depth at the center is close to 6½ in. In uniform-depth slab practice a 9-in. thickness is common, and slabs up to 10 in. are used. In general, the modern main-road concrete pavement has an 8- or 9-in. uniform depth section or a 9-6½- to 7-9-in. section with the edge thickening tapering gradually to uniform slab depth about 3 ft. from the edge.

A variation common in plains states that is grafted onto the standard sections as described is the marginal or lip curb. It has developed where topographical or soil conditions make it advisable to carry drainage on the pavement until suitable and safe discharge points are practicable. Commonly this construction is used as a defense against erosion and therefore more particularly in cuts where objectionable ditch erosion is likely and on fills where slope wash is dangerous. This type of section involves flume or spillway construction which is outlined farther on. The fact to be noted is that the marginal curb is added onto the normal section and is not considered as a strength element.

The divided slab is nearly universal. Only a few main roads omit the center joint. Its value in reducing longitudinal cracking is so great that it outweighs the design problem which construction and load transference present.

Joints—The center longitudinal joint to reduce cracking and transverse joints to provide for expansion and contraction are perhaps the most unsettled details of concrete pavement practice. The older theory—of no joints except construction joints where work was stopped and started—now has only a few adherents in practice. The longitudinal joint is virtually universal and transverse joints are general. Beyond this general agreement there is little uniformity in joint practice.

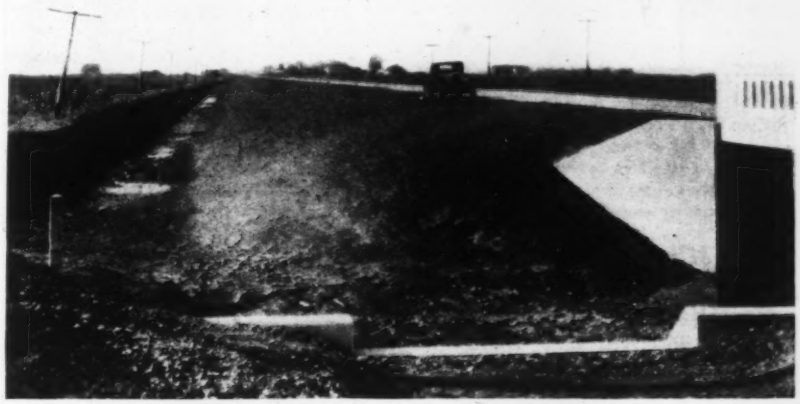
Type of joint, joint material, spacing and width of joints, use of contraction as well as expansion joints, joint support and other details show many differences. This is a reflection of equal differences in knowledge and theory of temperature and moisture movements, subgrade friction, concrete strength and freedom of joint action. Experiment and research are going ahead actively to determine these factors and are bringing a rational joint practice constantly closer to realization. Joints in recent pavements indicate decided improvement. They have been, because of crushing, spalling and unevenness, one of the details of concrete pavement most objectionable to travel and most troublesome to the maintenance engineer.

Theories of joint design and construction call for too extended a presentation for discussion here. The leading facts developed and being taken account of in recent design have a place. In presenting them longitudinal joints and transverse joints are considered separately.

Longitudinal joints are essentially devices to reduce longitudinal cracking. Conceivably too they have a modifying effect on transverse expansion and contraction. Their vital function is to reduce cracking by dividing the slab span and minimizing transverse warping and the effect of subgrade on longitudinal slab fractures. In accomplishing this they introduce the design factors of additional edge hazards and transference of loads across joints.

Past practice discloses three classes of center joints: a true expansion joint, either open or with a compressible filler which is generally used only in wider than two-lane pavement; an ordinary butt-construction joint generally used where the pavement is concreted one lane at a time; and a true contraction joint, which is prevailing practice and takes two common forms. These are the dummy joint, which consists of a groove cut part way through the slab, and the complete plane of separation, usually formed by a deformed metal plate which effects an actual division of the pavement.

For normal two-lane main-road pavement only the dummy joint and the plane of separation call for particular consideration and this in respect to the transfer of load across the joint. In case of the dummy joint the load is transferred by aggregate interlock or friction between the rough faces of the induced crack. Where the joint is a complete plane of separation, load transfer is provided for by the tongue-and-groove keying of the two joint faces and by across-joint steel dowels. Recent advance is indicated by closer dowel spacing but principally by increasing fundamental research in joint action, dowel efficiency and aggregate interlock. These studies are rapidly reaching toward knowledge that will enable more perfect center-joint practice.

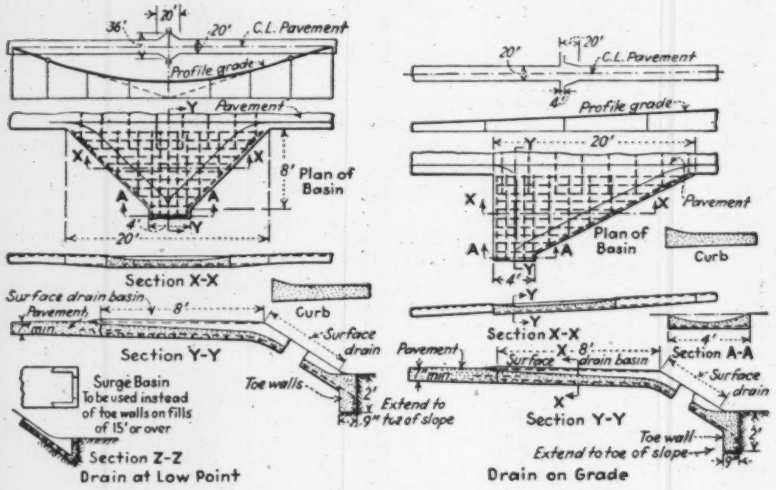


Gentle side slope on high fill, showing flat wide ditch and wide shoulder.

Transverse-joint practice in modern main-road paving shows no such uniformity as does longitudinal-joint practice. If a count of differences be taken as truly indicative, there is complete confusion. In reality the situation is much better. Joints are accepted essentials of the modern pavement, definite rules of spacing are followed, closer spacing is employed, contraction joints are grow-

ing in favor as supplements to expansion joints, joint structure is of higher type and joint construction is more exact.

Perhaps the clearest indication of joint improvement that is observable in main-road concrete paving is superior joint structure and construction. A more rational spacing is less obvious, reflecting the still very great uncertainty that continues regarding the proper integration of temperature, moisture, subgrade, reinforcing, aggregates, curing methods and other factors influencing the nature and amount of slab movement. Much the same indetermination is affecting the use of contraction joints. The broad statement can be ventured that expansion-joint spacing is very largely under



Types of spillway drains for concrete pavements with lip curbs.

rather than over 75 ft. and is commonly not over 50 ft. and, where contraction joints are used between farther-spaced expansion joints, the average transverse-joint spacing ranges from 40 to 50 ft. Expansion-joint opening per 100 ft. is from ¾ to 1¼ in. in the majority of states.

Returning to joint structure and construction, there is evident a determined search for a joint element that has superior resiliency, will not squeeze out and facilitates accurate placing. Examples to be noted are the cork joint and the steel air-cushion joint. The prevailing joint is still a premolded bituminous mastic strip. Considerable experimentation work is being devoted to joint elements but practice has been very slow to take up other than a bituminous product of some form.

Joint construction shows decided advance. The frequent joint failures of recent years have been rather closely determined by surveys to be due to: joints not perpendicular to the plane of the pavement; joint elements not deep or long enough to divide the slab completely; careless rounding of joint edges; dowels not accurately aligned with the slab, or frozen at the free end by grout penetration of the sleeve or lack of expansion space at the free end; marginal bars extending across the joint, and strutting of the joint by pebbles, blobs of mortar or infiltered soil. These are all plain construction faults that are receiving particular scrutiny in advanced practice.

Design elements of joint structure that are particularly in question are thickened slab ends at expansion joints, use of dowels at contraction dummy joints and the spacing of dowels at all joints. Surveys show almost invariable across-pavement cracking just back of the thickened section where thickened slab ends have been used. Dowels at contraction joints are considered to have advantage chiefly in holding the induced crack close and bringing the aggregate interlock into effect. In respect to dowels at expansion joints, while their use is nearly universal, opinion is increasing that at the common spacing of 3 ft. they offer little efficiency either in holding the slab ends in level or in transferring load across the joint.

Reinforcement—Crack control is the only function of reinforcement considered in advanced paving practice; its contribution to flexural strength, if there is any, is ignored. In crack control too the embedded steel is not considered so much an agency to prevent cracks as one to hold in close contact the crack faces so as to preserve aggregate interlock and prevent crack opening that will require filling. On this presumption rational design, although a reasonable theory and formula are available, is less often employed than judgment based on experience and practice.

The prevailing forms of reinforcement are fabricated mats of wire mesh or assembled bars, with the wire mesh product favored. The conclusions from practice appear about as follows: For usual highway conditions ample crack control can be obtained through the use of 50 to 75 lb. of steel per square if the steel is well distributed; with wire mesh mats the wire spacing should be from 6x6 to 6x12 in.; the position of the steel should be about 2 in. below the surfac and accurate in plane.

A multitude of survey and test da have been accumulated on crack contr by reinforcement, and they have led greatly improved practice both in distribution of steel and accuracy of place ment.

Finish and surface—The character finish varies greatly, but the tendency practice is away from the earlie smoothly troweled types to rough grained finishes such as are produced b brooming or wiping. Joint and sla edges are rounded, joint filler is plane down and high spots are ground off. Re quirements for surface are nearly uni versally limited to not more than ⅛-in variation from a 1-ft. straight-edge ap plied longitudinally of the pavement.

Brick pavement

THE ELEMENTS that make up the brick road are base, bedding course, brick surface and joint filler. The modern main road shows divergence in practice in all these elements. Structurally the greatest divergence is in character of base, which varies from flexible constructions of macadam and stabilized natural soils to rigid slabs of concrete. All have shown main-road qualities under individual conditions. The generally accepted standard for high-class modern main roads is the concrete base, and it alone is considered.

Most of the factors that make up a modern concrete pavement enter the design and structure of concrete base for brick pavement. The cross-section is a little, but not fundamentally, different; reinforcement is less used but is not unusual; joints to provide for expansions and crack control characterize best practice; trueness of surface is almost as rigidly exacted; concrete is of as high quality and is as accurately controlled as in paving. The concrete base of a brick pavement is in the most advanced design substantially the equivalent of a concrete pavement. It commonly shows no inferiority even in slab depth. With better surface and crack control, more exact and stable methods of bedding the brick surface have been developed. The bedding course is made thin, seldom over 1 in. deep; is of uniform thickness, and is templet-finished to true profile. A wide range of experimentation with bed-course material is going on; principally the search is for a method of fixing the bed by cementation. A bituminous mastic, a cement-sand mixture and self-cementing granulated slag are being employed. But even in the case of a plain sand bed, quite rigid requirements are enforced as to size and loam content of the sand.

In respect to the brick course the outstanding features of the latest practice are a reduced depth from 4 in. to 3 and 2½ in., the brick laid on the side to reduce joints, the favoring of a lug brick to ensure uniform joints, the availability

due to manufacturing advances, of a vertical-fiber lug brick and the beginning of development of a de-aired brick of exceptional density and strength. The broad effect of these developments and of more careful bricklaying practice is a cheaper and smoother brick surface of a superior kiln product.

At present, joint-filler practice is least satisfactory. The joint filler being used is bituminous ranging from pure bitumen of various degrees of hardness through a wide variety of mastic compositions. Extensive experimentation is now in progress with brick fillers.

A positive development of brick construction in modern main-road practice is the resurfacing with brick of old concrete pavements, using the old pavement with a revamped surface as a base. These resurfaced roads have reached appreciable mileages in several states and are giving some of the finest examples of main-road paving.

Bituminous pavements

BITUMINOUS pavements of main-road quality include an exceptionally wide range of materials and construction types. Both tars and asphalts are used in cold and hot mixtures; the construction type include penetration macadam, mixed bituminous concrete and sheet asphalt and bituminous concrete surfaces on concrete bases. These types may reasonably be considered the modern main-road types, although there is a fringe group of others that on occasion reach main-road qualifications.

The outstanding advance in all types is (1) more perfect technique for evaluating combinations of materials, (2) improved methods of control of bituminous mixtures and (3) improved methods of handling and placing in the field. Details of tests and control procedure are not a part of this discussion. Results may be summarized briefly as follows: Tests for stability have been developed by which strength of mixtures can be determined with far more certainty than has previously been possible. These test methods, once the mixture has been determined, enable also control of the uniformity of plant production. In brief, rational design and control of bituminous mixtures is well advanced. In general there has been improvement in equipment for producing plant mixes and decided progress in the use of machines for spreading and finishing all plant-produced bituminous road mixtures. The penetration-type road shows distinct advance in stabilizing the aggregate and in applying the bitumen filler so as to expose the surface aggregate and so retain a non-skid surface.

Bituminous surfaces, after passing through a period in which design and construction remained virtually stationary, are being developed to all the perfection in stabilized material production and in accuracy of finish offered by any type of surfacing.

Bridges and culverts

BRIDGE and culvert practice concerns the present consideration of the main road only as it affects continuity of road width and surface. The problems of statics, materials and types are the same, taking account of the loads and character of travel, as in bridges and culverts for other purposes. Design and structure as developed for main roads require indication only of certain special requirements. These are pleasing appearance, collision resistance, floor width, surface continuity of approach pavement and bridge floor and approach fences or guard rails.

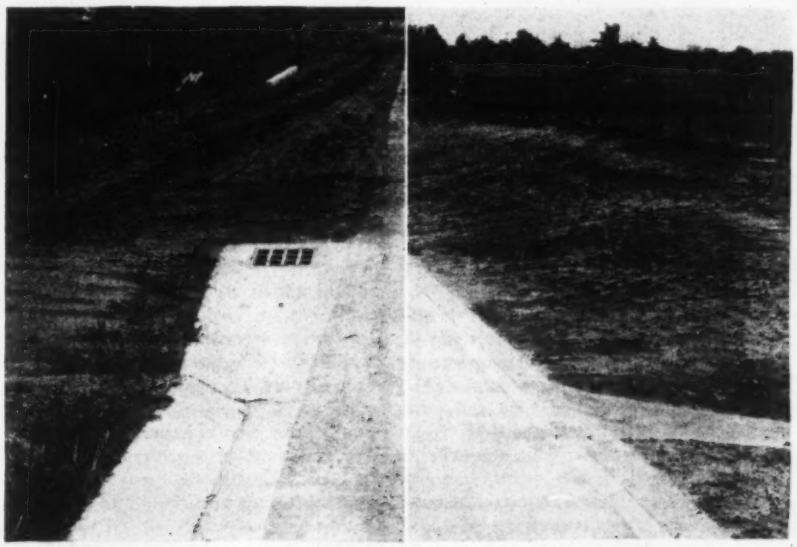
Attractiveness in the modern main-road bridge is being most generally sought by good structural proportions and graceful lines. The pasted-ornament period has ended. As the only views of the bridge by the traveler, except at intersections with grade-separation, are the approach, floor and railing, road bridges display commonly an emphasized attempt at architectural attractiveness in these elements. Normally the means employed are line and proportion which give the traveler a feeling of confidence in the safety and ease of entering upon and leaving the bridge and in the protection afforded him while on the bridge.

As constructed, the widening approach, guard rails, lane marking, curbs and railings give this protection actually as well as in appearance. Portals are particularly considered in respect to the impression of safety and strength conveyed to the traveler. Recent steel bridges have portals purposely framed not only to provide ample strength but to give a distinct impression of ruggedness and stability of bridge structure. Steel bridges often are painted to increase their visibility, the appearance of easy approach and of structural safety.

Adequate strength for the loads carried is being reinforced to an increasing degree in modern main-road design by design to resist collision. The motor vehicle is not mechanically confined to a track; it frequently enough runs off the track in approaching a bridge or while on it to constitute a collision hazard to the bridge structure, particularly of the truss type. Collision strength at portals and in truss design as well as collision protection by curbs and railings are fundamental provisions in the best modern road bridge.

Conception of the bridge as a continuation of roadbed and travel surface, and not an interrupting factor in safety, comfort and speed of travel, shows encouraging development in recent practice. The bridge of full-roadbed width has not arrived, but width exceeding the 20-ft. normal pavement sufficiently to give considerable clearance for off-lane vehicles is common. Culverts of full-roadbed width are general. Similarly to width of floor, advance is shown in design to secure continuity of longitudinal profile in the pavement approaching the bridge and the bridge pavement itself. The decided hump prevalent in older roads where the approach pavement joins at abutments with the bridge pavement is being eliminated by designing the approach slabs with beam strength to span settled fill and by other construction devices.

Catchbasin for ditch on grade and side drain for lip-curb pavement.



Materials

MATERIALS of high standards are employed in modern main-road pavement and structures, and their control by inspection and tests is rigid. It is doubtful if as high quality of concrete, bituminous mixtures, brick, tile and metal is commonly demanded for any other class of construction. An account of manufacturing and research development of roadbuilding materials calls for a recitation of details too extended to be considered. There is no error,

however, in the assertion that these developments have put the roadbuilder in command of materials of a high quality only dreamed of a few years ago, and he is using them generally.

Construction practice

CONSTRUCTION of the modern main road is predominantly a machine process. Except for trimming and finishing operations and certain services connected with the operation of machines, hand tools and hand labor occupy a very subordinate place. General and special work machines have been developed in as great number and for as many detail operations in roadbuilding as in any class of construction. A cataloging of kinds and functions must therefore give way in this discussion to an outline of outstanding advances in machine processes.

Grading — The magnitude of earth handling as a roadbuilding operation has increased with rectification of line and grade and the widening of roadway. Heavy excavation and fill are common. The power shovel for excavation (preceded by blasting operations in rock) is a universal tool and is supplemented by many types of dragline, pull-shovel, grab-bucket and power-scraper excavators. Hauling is by motor truck and tractor-trailer-trains where the excavator cannot overcast into fill. On the fill the power bulldozer is the prevailing device for heavy spreading.

For lighter earth-handling operations, particularly in tractable soils, remarkable advance both in machines and procedure has been made in scraper and blade-grader excavation and haulage to fill. Tractor-hauled and self-propelled scrapers and blade machines have provided speed, mobility, digging power and carrying capacity which have extended enormously the range of these tools for moving earth both across the roadway and along the grade.

In embankment construction the chief advances are in compaction of fills and in construction of fills across swamps. Construction in layers is common. With tractor and truck haulage, compaction of layers is to an important extent a product of the process. There is always the old stand-by of the power roller. The outstanding newer device for compaction is the water jet. Jetting has in recent practice shown great efficiency in settling and consolidating many classes of soil and also the development of an important technique. Similarly the stabilizing of embankment across swamp by blasting has advanced to a high degree of certainty of results. Both jetting and blasting have advanced to the position of recognized methods of main-road embankment construction.

The mechanization of grading has reduced costs and increased speed. Any quantitative estimate of the gain is not easy but the general facts are apparent. They are due in part to greater volumes but more largely to machine improvements and new work methods: gasoline and diesel power, crawler tractions, carriage mountings, design and operating improvements, two and three-shift and night work and more skilled direction of the work. Another gain has come from reduction in overhaul charges due to greater speed and larger loads of truck and tractor haulage and, by cheaper blasting processes and more powerful excavators, from less need of classified excavation. All these reasons have made economically practicable the greater grading volumes that wider roadway and rectified line and grade make necessary.

Paving—Modern main-road pavement is a product of machines and special tools. This statement is wholly true of bituminous and concrete pavements and of materials and base for brick pavement, but laying the brick is a hand operation. Concrete, being used for pavement and as a base for brick and commonly for bituminous main-road pavement, has been given most attention. Equipment and processes have been highly developed.

The outstanding features of advanced practice in concrete pavement slab construction are: (1) close scrutiny of materials to secure durable rock and better gradation of sizes; to some extent selection of cement of low-heat developing characteristics; (2) dry mixes and aggregate in two or three sizes remixed to secure more perfect gradation; (3) use of bulk cement because of less first cost and economies experienced in handling, decreased waste and utilizing full-batch capacity of mixer; (4) proportioning by weight to eliminate variation due to changes in rock, volume of voids and bulking not detected in proportioning by volume; (5) automatic operation of paving mixers which speeds up output; use of two or more mixers in sequence for mixing in installments to increase number of batches per mixing period; (6) improved jointing devices and methods to secure accurate joint construction; (7) machine-spreading and surfacing of concrete slab; (8) test by straight-edge for true plane of surface; (9) broomed or wiped-surface finish to modify glare and increase traction; (10) introduction of vibration to compact concrete; (11) introduction of transit mixing and of spreading machines, with central plant proportioning.

Not all these devices and methods are always used and not all are necessary to ensure modern main-road quality; other practices satisfy the same requirements but those indicated express advanced development. There is today a machine or device for every operation indicated and their use is common. This mechanization, combined with skill and management methods developed by a body of engineers and contractors who have specialized in the work, has developed high speed and economy in concrete paving. A daily average of 1,000 ft. of 20-ft. pavement is common, and runs of more than 2,000 ft. a day are not uncommon. With a 1-min. mix a batch placed every 75 to 90 seconds is secured on better operations with the regulation paving mixers, and with tandem mixers a batch every 50 seconds has been realized in regular operation. A paving gang of 50 to 75 men is sufficient for these outputs in the ordinary run of roadbuilding.

The construction of concrete base for bituminous and brick pavement employs all the devices and methods employed in concrete pavement construction. Laying the brick, culling the defective units and filling the joints are manual operations with hand tools; the road roller is about the only heavy equipment used or required. Hand-operated templets are about the only devices other than hand tools used in spreading and smoothing the cushion course. Brick surfacing employs a minimum of equipment, and experiments have not shown that change in this respect is economically justified.

In placing and laying bituminous mixes, hand spreading and raking, once universal, have been replaced in advanced practice by machines. The result is a more uniform density of surfacing and a much smoother surface. With machine finishing there has come more careful rolling, which with more stable and better controlled mixtures has greatly advanced bituminous concrete as a main-road material. The excellence of penetration construction lies mostly in selection of sound, hard aggregate, careful sizing of aggregate, its careful spreading and uniform compaction by rollers, the even application of the oil or tar by pressure distributors and the careful elimination of bituminous mat on the surface.

Conclusion

A CLOSING WORD is necessary to give credit to the part that the testing and research laboratory has played in developing the main road. Research and tests have improved materials, structural design, construction methods and equipment and have searched into the nature of traffic and the economics of investment and operation. In its best examples the main road is the product of the engineer's wise application of the facts and principles developed by the laboratory worker and field investigator. They have had a controlling part in the evolution of the main road. Nor should ample credit be denied the road contractor who has developed an organization, mechanized his operations and acquired a specialized skill to a degree of excellence surpassed in no other class of engineering construction. And finally the manufacturer of materials and construction machinery has moved in step with the investigator, engineer and contractor and often has anticipated their needs.

Two-Year Construction Needs Set at Thirteen Billion

Deficits in housing, grade-crossing and other construction fields estimated by a government group as basis for a possible business-recovery program of construction

ESTIMATES of deferred and needed construction, both public and private, have just been completed by a governmental research group at Washington in connection with proposals for a large recovery program of construction. These estimates place the total of needed work at more than thirteen billion dollars. The committee suggests that this volume of construction is available as the basis for a two-year program of stimulated construction. Large items in the total are 4½ billions for housing and 5½ billions for transportation facilities, which together make up more than two-thirds of the programmed volume.

Execution of a two-year program as outlined would involve monthly expenditures increasing to nearly $700,000,000 a month during the second year and would employ at least 4½ million workers. Government financing and administration of the work are considered essential.

In the background of the estimate is the belief that effective and sustained recovery requires expansion of the industries producing capital goods, primarily construction. The heavy decline in capital-goods employment, which in the field of construction exceeded 75 per cent, has contributed several million men to the ranks of the unemployed and by indirect influence a greater number. At the same time the decline in volume of construction has piled up a deficit in public and private facilities which represents an actual shortage, even though a short-time view might lead to the conclusion that additional facilities are not now needed.

Housing deficit and requirements

Two different estimates of housing requirements were made by the group; they check closely, and indicate a normal need of about 800,000 homes per year. Increasing this figure to include homes below decent living standards, but making no allowance for accumulated deficit, it is computed that during a period of two years the construction of 2,000,000 homes (houses or apartments) would be justified as response to existing needs.

Figures for a number of cities show new housing construction to average 4.5 per cent per year of the number of urban families. The data are for the five highest building years before 1929, but they are held to give a fair value of the amount of housing that might be built during several years. This figure is 765,000 units per year, requiring an investment of about 2½ billions. The second estimate was based on the increase of urban families during the past four years (595,000), the prospective return to cities of families that moved to the country during the depression (250,000) and the unreplaced fire loss (100,000), with adjustment for obsolescence, vacancies and oversupply. This calculation gave the figure of 810,000 homes. Adding the estimated number of homes below proper living standards in 1929 (1,250,000), a total present housing need of 2,060,000 is indicated, involving a total investment of $4,530,000,000.

Public-works deficit

Expenditures on recreational facilities, including parks, schools, beaches, stadiums and the like since 1929, together with the needs for the coming two years, represent an accumulated deficit of about $450,000,000. Expenditure in this field is considered to be more necessary in future because of increased leisure of the individual due to the recovery program, and the above amount therefore is taken as a minimum requirement.

Expansion and improvement requirements in water supply and sewerage, refuse disposal, hospitals and similar facilities serving health and sanitation represent a present total of $1,650,000,000. This sum includes about $500,000,000 for water supply (A.W.W.A. estimate of immediate needs) and $800,000,000 for sewage-treatment plants (American Society of Municipal Engineers). The deficit in public buildings is reflected in a drop from expenditures of $161,000,000 in 1929 and $181,000,000 in 1931 to about $50,000,000 in 1933, and the requirements by the end of 1935 are taken at $136,000,000.

Highway, grade-crossing and railroad work

Present needs in the highway field appear to center on express highways between major cities where traffic is already beyond the reasonable capacity of present facilities. The advisable two-year expenditure on such arteries for both truck and passenger service, added to the requirements of normal highway developments, are taken at $1,800,000,000 during 1934 and 1935, but this figure is conservatively cut to $1,000,000,000 for inclusion in the program. Economically justified grade-crossing elimination and related improvements ready for early construction is estimated at $2,400,000,000. Delayed railroad-roadbed improvements and further improvements necessary to maintain railroads in proper competitive condition to highways represent an opportunity for profitable expenditure of $1,500,000,000, which is increased by needs for development of terminal facilities to about $2,000,000,000.

Based on these estimates, a program of transportation improvement construction for the next two years, totaling $5,400,000,000, is suggested as economically warranted.

Requirements as to factory and commercial building construction are less certain on account of recent overbuilding on the one hand and prospective shift in manufacturing locations due to decentralization on the other. Accordingly, a two-year estimate is set at only $600,000,000, which is a fraction of what calculations, based on several different methods of approach, indicate. Educational requirements are placed at about the same figure. Necessary expenditures in modernization that would be possible under a nation-wide public campaign properly directed and financed are estimated to reach $650,000,000.

The program may be summarized as follows:

CONSTRUCTION REQUIREMENTS, 1934-1935

Housing	$4,533,000,000
Recreational facilities	418,000,000
Health and sanitation	844,000,000
Public buildings	136,000,000
Transportation facilities	5,400,000,000
Industrial and commercial buildings	600,000,000
Educational facilities	685,000,000
Modernization	650,000,000
Total	$13,266,000,000

Under an adequate system of financing and administration, a large part of this program could be put in motion within 60 days, it is held. Increasing in activity from this point, operations would accelerate to a sustained monthly rate of $690,000,000 in the second year.

Financing the emergency construction

In the past nearly half of the financing of construction has come from banks, and the rest from mortgage companies, insurance companies and private investors. Under present conditions no material amount of financing is to be expected from these sources, and a large emergency construction program must therefore be supported by governmental agency. Existing organizations, including the R.F.C., the Public Works Administration and the Civil Works Administration, are not at present adequately financed to provide more than an initial part of the money. It appears, however, that the Home Loan Bank system might develop

its operations in such a way as to provide a secure method of furnishing construction funds.

Under any plan of governmental financing the complication of having to deal with a great number of individuals and projects might be expected to hamper operations in such a way as to produce fatal delay in the program outlined. By pooling property to form districts to which the government loans would be made, however, both administration and security of loan can be improved sufficiently to render the plan workable. Since the entire undertaking should, for proper control, be tied into the existing system of realty management, a government unit of Real Property Administration would form a means of handling the loans and direction of the work effectively and securely. Such an agency would combine the powers of the Public Works Administration, the Home Loan Bank and the R.F.C.

It is considered essential that any such plan of stimulated construction supported by public financing should be guided by the data furnished by a real-property inventory. As the Cleveland inventory has already shown a direct relation between economic and population facts on the one hand, and health facts on the other, such an inventory would serve as guide to the public-works as well as the housing, building and transportation elements of the plan.

Building Demolition Requires Orderly Program

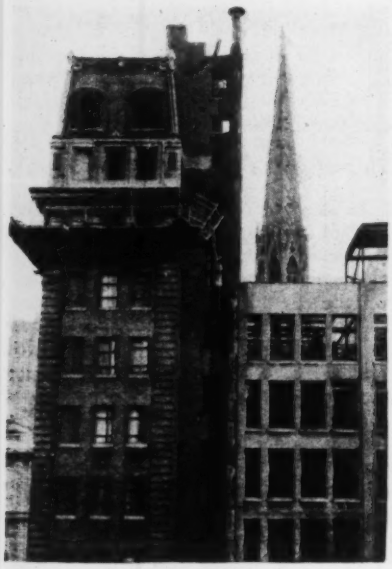
On old structures on Rockefeller Center site interior gutting operations began at bottom and moved upwards followed by wall razing moving downward—Debris dumped into basement removed with power shovels

MODERN building demolition requires a technique quite as much as does building construction, and requires it for the same reasons—namely, speed, economy and safety. A method developed by one of the leading wrecking firms in New York, the Albert A. Volk Co., and used by this organization in removing the old buildings from the three-block site of the Rockefeller Center development in New York, is known as the "upside-down" method. In this method of demolition the work starts with gutting in the interior of the structure, beginning at the bottom and moving upward, leaving only enough of the structural frame in place to support the walls. After stripping the interior by this process and permitting the debris to accumulate at the bottom of the building shell, the contractor begins at the roof to take down the walls, in most cases also dropping this debris inside the building as before. When wrecking has proceeded as close to the first floor as the accumulated debris will permit, a power shovel attacks the mass of wreckage, completing the destruction of the walls and loading the material into trucks. This method is claimed to be much faster than the practice of starting wrecking operations at the top of the building and using chutes as a means of disposing of the rubbish.

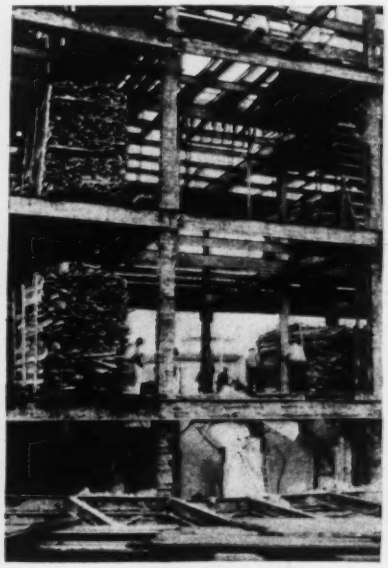
In the three separate contracts for the Rockefeller Center work some 200 buildings were removed. The last contract involved 35 buildings on the east end of the north block. The structures ranged in height from a six-story wall-bearing structure to a twelve-story skeleton-frame building; 26 of the buildings were four- and five-story non-fireproof residences built with party walls.

In wrecking the residences, key structures at intervals were first removed. Then the front and rear walls and partitions of all of the residences were demolished and the party walls were

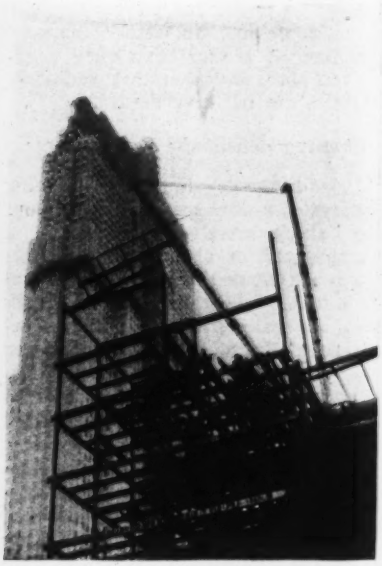
Side walls of the residences were pushed down one story at a time.



Catch scaffolds for safety.

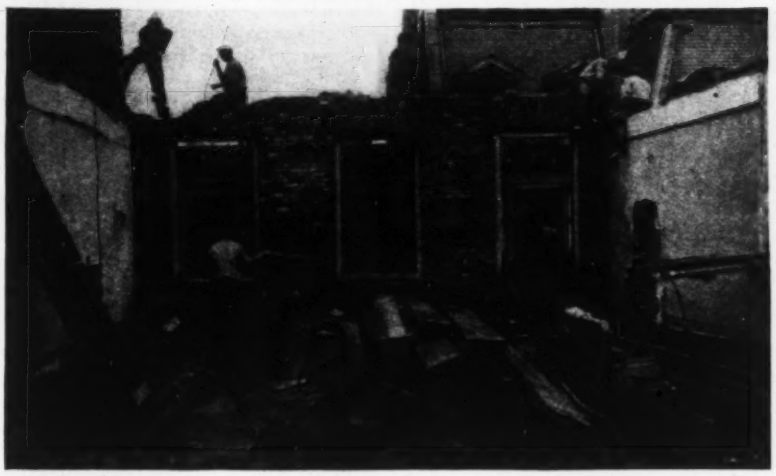


Truck-size bundles of old lumber.



Lowering flame-cut frame sections.

Power shovels complete the demolition job by loading debris dropped from above and by wrecking lower-story walls.



Water is continually played on the debris to lay the dust. Note the floor openings around the walls through which materials are dumped into the basement.

pushed down a full story at a time, saving the labor of breaking the masonry with sledge hammers and bars.

Since these non-fireproof residences had wood floor frames and flooring, it was necessary to preserve the rigidity of the floor system in order to maintain stability during the first wrecking stages. For this reason the joists were disturbed as little as possible, and rubbish from above was dropped through trenches cut in the floors. In steel-frame buildings, of course, it is possible to remove both the flooring and the wood secondary framing when cleaning out the interior.

Stripping the interior

As the first step in wrecking many of the buildings, the contractor salvaged mantelpieces, doors, wood panels and other objects of value, which were sold, or in a few instances given to museums. Plaster and lath and all wood except that in the structural frame were next removed. On the smaller buildings the wood was thrown out on the sidewalk bridge; in the taller structures it was made up on each floor into firewood bundles to fit trucks. Heavy wood pieces were saved and sold for rough use.

With as much of the interior removed as possible, the wreckers dismantled the roof and roof frame and began the demolition of the walls. On the residential buildings the walls were pushed over one story at a time, as stated, but on the taller wall-bearing fireproof and semi-fireproof structures the masonry had to be broken down with sledge hammers and bars. On the heaviest masonry walls, holes were drilled (with pneumatic tools) on 2-ft. centers vertically and on 3-ft. centers horizontally to permit the insertion of plugs and feathers. On the fireproof wall-bearing buildings it was possible to remove all the concrete from the floors wherever desired, leaving only the steel frame. On the semi-fireproof structures the wreckers stripped all the flooring but turned the wood joists flat and placed them on the lower flanges of the steel beams to form temporary floors for use during wall demolition.

Skeleton-frame buildings

Two methods were employed on skeleton-frame buildings—stripping the entire skeleton before starting to demolish it, and starting burning and dismantling the steel after about four floors had been completely stripped. As a part of the stripping operations of the skeleton-frame buildings, it was usual to cut a trench in the concrete floor around the entire periphery of the building. The wreckers worked from suspended scaffolds hung from the top of the steel frame on the outside of the building in breaking up the walls with sledge hammers and bars, permitting the debris to fall through the floor trenches to the basement.

When the frame stripping had proceeded sufficiently, a guy derrick was erected on top of the steel skeleton, and burning and dismantling of the steel began. Derricks were dropped down as demolition proceeded.

It was found on the work that a 1½-yd. gasoline shovel could load a 7-yd. truck in 3 min., as compared with about 30 min. by means of a chute. The power shovels furthermore were effective in rapidly demolishing first-story walls. A power crane also proved useful in sorting and loading structural steel.

Safety measures

Catch scaffolds were built around the taller buildings to intercept any dislodged material that otherwise might have fallen through the sidewalk bridge. Usually these scaffolds were moved down four stories at a time as wall demolition proceeded. Fully inclosed safety stairways, for the use of the workmen, were maintained. Windows of structures more than five stories high were boarded up completely, to prevent the escape of dust or debris. Water lines were installed, and workmen played streams of water on the rubbish continuously, thus preventing the formation of dust.

The demolition work was directed by A. K. Fleschner, secretary, and Michael Sheriff, superintendent, both of Albert A. Volk Co.

Terracing Farm Lands

Terracing of farm land has continued actively during the past year in spite of financial difficulties, according to a report of the U. S. Bureau of Agricultural Engineering. Nearly 1,500,000 acres were terraced on over 44,000 farms under supervision of the extension office of the Department of Agriculture. During the last ten years nearly 13,000,000 acres on 400,000 farms have been terraced according to the recommendations of the Bureau.

Huge Hammerhead Crane for Puget Sound Navy Yard

Turntable crane of 250-ton capacity selected for rigidity and precision in placing load —Model tests are used to verify stresses

By Wm. H. Fowler
Secretary, Dravo Contracting Co., Pittsburgh, Pa.

DESIGN, fabrication and erection of modern heavy-duty cranes for shipyards involve procedures less familiar to the structural engineer than are most operations of bridge work and building where steel construction is employed. It is believed, therefore, that an account of the design and construction of the new 250-ton (gross) crane recently installed at the Puget Sound Navy Yard, Bremerton, Wash., for the Bureau of Yards and Docks, U.S.N., will have interest to structural-steel designers and erectors.

In selecting the type of crane the decision was influenced by the fact that in a fixed position on land the turntable type gives smaller deflections, is highly stable and affords greater precision in placing loads. The last quality is of distinct advantage in the frequent task of mounting and dismounting heavy guns on warships.

General description

The crane consists of a fixed tower structure of octagonal cross-section carried on a square trussed portal. At the top of the tower, which is 125 ft. high, a deep box-girder system carries the rolled-steel track on which rests the live roller circle. This circle consists of 80 forged-steel tapered rollers forming a roller ring about 60 ft. in diameter. The rotor consists of the boom with its length of front cantilever (190 ft.) carrying the trolleys and its rear cantilever (120 ft.) carrying a house for the operating machinery and concrete counterweight, all carried on two semi-circular welded box girders with their rolled-steel tracks resting on the live roller circle.

The main load of 250 gross tons is carried on a balance beam supported from two trolleys of 115-ft. travel, while an auxiliary trolley of 30 gross tons capacity runs out to an extreme working position at 180-ft. radius. Monorail hoists of 5-gross-ton capacity are carried at each side of the boom on tracks supported on brackets from the main structure to provide for higher lifts and to reduce rotation of the boom for light loads. The machinery house is provided with a 25-ton crane for erection and maintenance.

The machinery house on the rear cantilever was designed as a two-story structure, the hoisting engines on the lower level giving a direct lead of all hoisting lines to trolleys and eliminating deflecting sheaves. The rotation of the superstructure is effected by two motor-driven swinging machines carried on the front and rear cantilevers, with their driving pinions meshing in a cast-steel rack supported on the roller track of the tower structure. All operations are controlled from the operator's cab located on the front cantilever. An elevator and a stairway provide access to the top of the tower, from which point stairs and walkways lead to all parts of the superstructure.

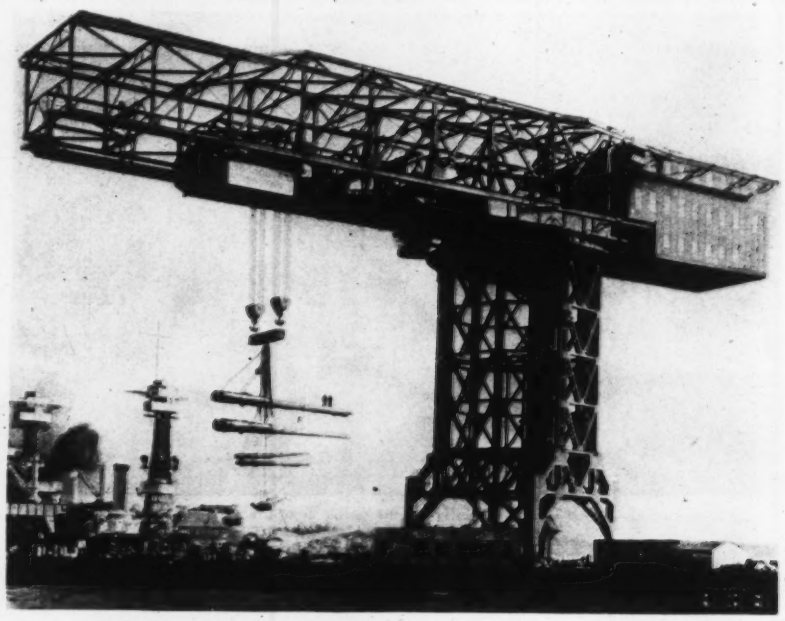
A special effort was made throughout the design to eliminate all lacing bars where possible and to use rolled-steel sections. The speeds of the various motions of the crane are as follows in feet per minute:

Load, Tons	Hoisting	Slewing
250	7.6	One Rev.
30	1.5	in 6 min.

The pier on which the crane is located was built in 1926, and at the time a 350-ton crane was proposed, similar to that at the League Island Navy Yard, Philadelphia; consequently the foundations for the crane had bed plates and anchor bolts set to accommodate a square portal with column centers 56 ft. in each direction. To suit the existing foundation, the tower structure of this crane necessarily consisted of a square four-column base with deep portal trusses carrying the main tower shaft, which was made octagonal in section. The eight columns of this tower consist of three girder-beam sections riveted together to form an H-section, and they support an octagonal box girder at the top of the tower with an elevation above the dock to the top of the girders of approximately 125 ft.

Model test of tower

As the design of the tower structure progressed, it was soon evident that one should have a very definite knowledge of the action of forces in the various members in order properly to proportion these members with respect to each other and to have them function correctly under the application of a heavy concentrated load moving around the top of the tower. In order to secure definite information regarding the distribution of stresses, it was decided to build and test a model of the tower structure. The model, of welded construction, was made on a scale of ½ in. per foot and was proportioned according to the orginal design proposed. The loading of the model during the test, which was made in the research laboratory at Lehigh University, Bethlehem, Pa., was done as nearly as possible under conditions that simulated those that would obtain in the completed structure.



Crane at Puget Sound Navy Yard during test lift of 700,000 lb. at 115-ft. radius.

The primary object of the test was to find the path taken by the various loads and the general distribution of the concentrated load when it should reach the bottom of the columns and to determine as nearly as practicable the probable plane of the track under various loading conditions, and particularly under the condition of maximum eccentric loading. In general, the results of distribution of loading, as shown by the deflections, corresponded closely with the assumption that a load applied at the top of the tower in an eccentric position would distribute at the base of the tower according to the position of the individual columns with respect to the position of load, and this theory was checked closely enough to be satisfactory for all practical purposes.

Bracing design changed

The design, as originally contemplated, was based on using standard X-bracing between the main columns, assuming that it would be a tension system. But the strain-gage readings did not verify the assumption that the X-bracing system worked in tension; it was found that both members of the X-bracing system took compression stresses, particularly when two adjacent columns were loaded equally. As a result of these tests the final design was based upon the use of the so-called K-brace system, as shown in the adjacent illustration. This change of bracing was very satisfactory both from the standpoint of rigidity, appearance and economy of design.

Shop fabrication

All fabrication of the crane was done in the Pittsburgh plant of the contractor. In order to safeguard against possible delays in the field, sufficient shop assemblies were made to insure that all main members would fit together correctly when erected at the site. One complete portal truss was erected for the purpose of checking connections, as were two of the main tower columns with one set of bracings. The main trusses were fully assembled at the plant, and after being set to the proper camber all joints in the trusses were reamed, as the trusses were to be erected in the field as cantilevers without falsework.

In order to machine the tops of the octagonal box girders forming the base of the lower roller path, as well as all roller paths, segmental girders and slewing rack, it was necessary to build a special rotary planer.

Field erection

All materials were shipped from the manufacturer's plant at Neville Island to Baltimore by rail and thence by water to Bremerton, Wash., where the ship discharged directly on the pier at the site of the crane. A steel tower 30 ft. square and 150 ft. high with spread base was built to accommodate itself to existing tracks on the pier at 56-ft. centers. Two wheels were used at each corner of the tower, so that the tower could be moved back and forth on the pier readily. After each movement of the tower, blocking was inserted between the trucks and the concrete deck so that the wheels would be quite clear of the rail, in order to prevent any possible movement of the tower. Two stiff-leg derricks with 85-ft. booms were mounted on the corners of the top platform adjacent to the crane structure. All hoisting and swinging engines, as well as operator's stands and controls, were mounted on the top of the tower, to which a stairway gave access. The rating of the derricks was 15 tons each at 80-ft. radius. Counterweight was added at the base of the tower to provide the necessary stability.

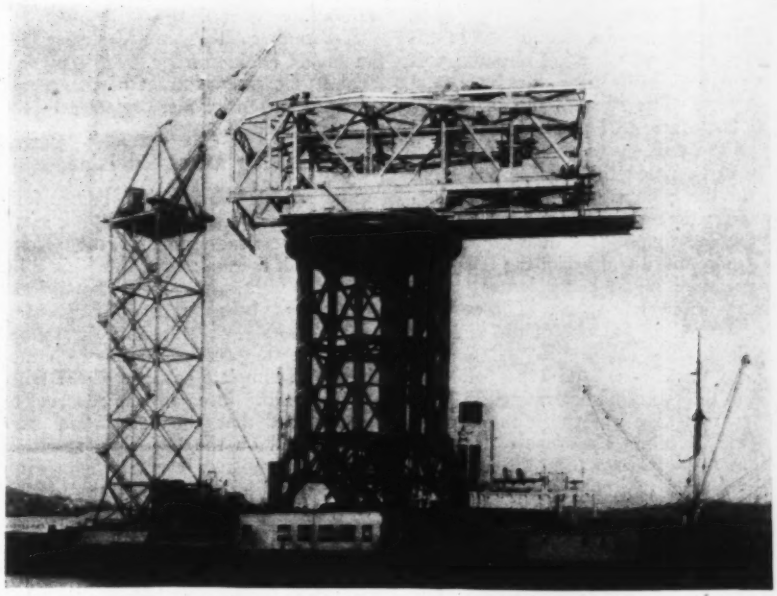
The erection derrick tower was set up on the pier inland from the crane location. The entire crane structure was erected with this one piece of equipment, except that the portal of the crane was partly placed with a locomotive crane during the period of erection of the tower derrick. Erection continued with the tower derrick in its original location, directly adjacent to the crane site, until the building of the cantilevers was begun. At this period the tower derrick was backed away to a proper distance to permit the building of two panels on each cantilever. The first two panels of the front cantilever were erected, after which the superstructure was rotated to permit the erection of the rear cantilever. This performance was repeated, the superstructure was rotated back and forth, and the tower derrick was moved away successively until the final members were placed at the extreme end of the front cantilever.

The first shipment of steel arrived at the site Aug. 25, 1932, and all erection was complete, with the crane ready for preliminary tests, on Feb. 20, 1933.

The precautions taken at the plant during fabrication, the making of shop assemblies and the proper scheduling of manufacturing and shipping resulted in the erection at the site proceeding with remarkable ease.

Tests

Acceptance tests were based on the specification that all operations be made as would be required during the operation of the crane and with maximum test loading of 125 per cent of the normal rated load. During the period of running tests a careful record of deflections was made in order to check computations made during the design period.



Erecting 250-ton Navy Yard crane with 150-ft. traveling tower derrick.

With the test load of 700,000 lb. at 115-ft. radius, the deflection at this point was 3¼ in. The trusses, when reamed in a horizontal position at the time of shop pre-assembly, were given an upward camber of 6⅞ in. at the extreme end of cantilever, with calculations showing that the remaining camber under dead load only would be 5.022 in.

A check after completion of erection showed a remaining upward camber at the extreme end under this condition of 5.00 in. The tower structure, under no load, leaned backward 1/6 in., and with the full load of 250 gross tons at 115-ft. radius the leaning of the tower was forward and amounted to ⅛ in. With the maximum load on a single main trolley (about 350,000 lb. at 115-ft. radius) the difference in the elevation of the two trusses caused by this eccentric loading was ¼ in.

Calking Stressed Welded Joints Caused Oil-Tank Failure

Report of accident to 80,000-bbl. storage tank at Tiverton, R. I., attributes failure to calking a leak in an imperfectly welded joint in second ring of plates while tank was full of salt water

THE COLLAPSE of the 80-000-bbl., arc-welded, oil-storage tank at the plant of the New England Terminal Co., Tiverton, R. I., on Nov. 1, 1933 (briefly reported in our news pages two weeks ago) was investigated by the inspection department of the Associated Factory Mutual Fire Insurance Companies, Boston, and reported upon Nov. 16 by H. A. Sweet, engineer of the department. According to the report, "A likely cause of the collapse is that a highly stressed, electrically welded joint in the second course toward the bay was leaking slightly, was being calked while under pressure, and gave way. The rupture spread rapidly until large areas of plates were forced out of the tank by the escaping water." It is to be noted that three lives were lost in the collapse; that the dike surrounding the tank gave way; and that a wave overtopping the dike demolished the pump house and broke the oil pipes, the escaping liquid being ignited probably by an electric spark. The ensuing fire involved all but one of the tanks at the plant.

Plate thicknesses and types of weld used in the tank and determined by field observations are shown in the accompanying sketch. The report lists five lessons to be learned from the accident:

1. Suitable regulations should be generally adopted for the design and construction of welded gravity tanks.

2. Large welded tanks should not be calked while filled. If leaks or other defects are found during tests with water, the tank should be drained immediately to a point below the leaks and defective material removed, rewelding where necessary. The tests with water should be repeated.

3. Better field inspection of welding is necessary.

4. Due to the relative newness of welding and to the possibility of not obtaining perfect workmanship, more conservative designs should be used. Only welders who pass regular qualification tests should be used for major welding.

5. Stronger dikes are desirable for flammable liquid storage.

The following abstract of the report gives the essential facts relative to the tank failure:

Calking a stressed joint

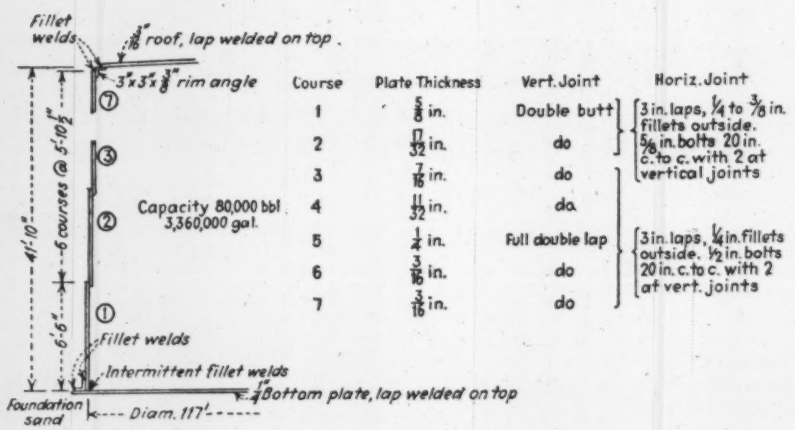
The reported events just before failure are that welders were stopping small leaks in vertical seams of the second course with the tank filled to within 8 in. of the top with salt water. A small leak, which was being calked by peening with a hammer, developed into a stream, then the plate gave way, followed immediately by complete collapse of the tank.

The welding foreman was reported to have stated that the foundation may have settled on the bay side, resulting in overstressing of the tank plates on that side and leading to collapse. However, there was no clear indication of settling near the break in the dike. The tank bottom rested on earth without concrete foundation. There was an open 8-in. hole in the roof of the tank, so that excess air pressure during filling with salt water could not have caused the collapse.

The collapsed tank had a unit stress at the base of the solid plate of 21,000 lb. per sq.in. when filled with salt water, corresponding to a factor of safety of 2.6 for plates of 55,000 lb. per sq.in. ultimate strength, with 100 per cent joint efficiencies.

Several failures in the third and fourth courses occurred, probably after the initial break, at the base of vertical joints where upper and lower courses were lapped. Welding on the outside of the joints tore away from the lower plate, indicating that the outside vertical welds should be continued down to good penetration in the top of the lower solid plate and then extended along the horizontal joint as a full fillet weld, with good penetration, for at least 3 in. in either direction.

Details of arc-welded 80,000-bbl. oil-storage tank which collapsed under a full-test load of salt water.


Fillet welds
roof, lap welded on top
3"x3½"x⅜" rim angle
Course
Plate Thickness
Vert. Joint
Horiz. Joint
1 5/8 in. Double butt
2 17/32 in. do
3 7/16 in. do
4 11/32 in. do
5 1/4 in. Full double lap
6 3/16 in. do
7 3/16 in. do
3 in. laps, 1/4 to 3/8 in. fillets outside. 5/8 in. bolts 20 in. c. to c. with 2 at vertical joints
3 in. laps, 1/4 in. fillets outside. 1/2 in. bolts 20 in. c. to c. with 2 at vert. joints
Capacity 80,000 bbl 3,360,000 gal.
6 courses @ 5'10½"
4'1"10"
6'6"
Fillet welds
Intermittent fillet welds
Bottom plate, lap welded on top
Foundation sand
Diam. 117'

Some recommendations

1. While some states prohibit large welded oil-storage tanks, the increasing popularity and use of welding make it preferable to have proper regulations rather than to prohibit such construction. At present, minimum strength requirements are left to the decision of the individual manufacturer. States and interested organizations should draft regulations.

2. Calking of a welded tank when filled, especially if highly stressed, is dangerous. While it has always been common and safe practice to calk riveted joints of gravity tanks while filled with water, the calking edge of a bevel-sheared, riveted plate carries no stress, and great care is taken not to damage in any way, or even to hit, the main plate with the round-nosed calking iron. "Calk-welding" is also dangerous because the steel may be softened sufficiently by the temperature of the arc to cause rupture of the joint. In repairing leaks the only safe procedure would seem to be to lower the water level, remove the defective material, re-weld and re-test.

3. The prime need for reliable inspection of field-welding seems to be in the immediate development of a small portable X-ray machine or equivalent device of moderate cost. Also, very complete surface inspection of all welds is necessary.

4. With respect to unit stresses, it is recommended that a factor of safety of 3½, figured at the base of the plate and referring to the minimum ultimate strengh of the plate, be used. Plates should be rolled to standard A.S.T.M. specifications. So-called "tank steel," without definite specification, should not be used.

5. There probably is an accumulation of sulphurous acid sludge in the bottom of large fuel-oil tanks which should be completely drained off frequently to retard corrosion. Excess parent and weld metal in the bottom 6 in. of such tanks would be advantageous. There should be a continuous weld inside the tank between the bottom plate and the base of the shell plate.

Economics and Operation Lead Highway Board Subjects

Majority of papers at thirteenth annual meeting of Highway Research Board treat cost analysis, evaluation of earnings, traffic surveys, tractive resistances, vehicle speeds, traffic control and allied subjects

A DISTINCT departure from precedent marked the thirteenth annual meeting of the Highway Research Board in Washingeon, D. C., Dec. 7 and 8. Instead of concentrating on materials research and roadway design, as formerly, the program emphasized economics and operation, nearly three-quarters of the subject matter presented being devoted to these fields of thought. The attendance was good. The George S. Bartlett award for meritorious achievement was presented to James H. MacDonald, former head of the Connecticut state highway department (*ENR*, Dec. 7, 1933, p. 693).

Highway economics

The subject of transportation economics was introduced by R. W. Crum, director, Highway Research Board, in a paper setting forth general principles of highway evaluation, including the relationships between annual cost and earnings and between the physical character of the road and vehicle-operating costs. The paper was a résumé of the three articles Mr. Crum published in these pages under the subject of "How the Highway Pays" (*ENR*, June 29, July 6 and July 13, 1933).

Dean Anson Marston (Iowa State College) carried the subject farther in a paper on "Physical Valuation of Highways," in which he urged engineers to look upon themselves as managers of public utilities rather than as builders of roads. As managers they will be more concerned with efficiency than ever before. What taxes are to be levied and how they are to be distributed become vital problems that must be separated from political expediency. As a basis for demanding this separation, highways must be valued as any other public utility—a railroad, for example—would be valued. A standard system of accounts is particularly desirable. Values taking into consideration actual original cost and reproduction cost new must be determined. Some rational means of estimating earning value must be devised. Modern methods of depreciation must be generally agreed upon and followed if investments in highways are to be protected and soundly amortized.

The principal tool to be used in evaluating the service rendered by highways is the traffic survey. E. W. James (U. S. Bureau of Public Roads) reviewed the various types of traffic surveys that are necessary to secure answers to the multitudinous questions that arise. The basic need of traffic engineers is to know how large a sample of traffic must be taken before it can be representative enough to form the basis for general conclusions. The Bureau of Public Roads is planning to analyze the records of traffic through the Holland Tunnel and over the George Washington Bridge at New York in the hope of securing an answer to this question.

Time saved by New Jersey viaduct

The recently completed high-level viaduct between Newark and Jersey City is one of the most expensive pieces of highway in the world (costing $5,200,000 per mile) and also one of the most heavily traveled, as it is a part of the approach road to the Holland Tunnel at New York. Of the various economies claimed for the new route in the preliminary studies, one was the saving in travel time over the old ground-level route, which involved two drawbridges and several intersections. Lawrence F. Tuttle (U. S. Bureau of Public Roads) presented the results of a field study of travel time between the same points before and after the opening of the viaduct, which is clear of all intersections at grade and is 3.7 miles long as compared with 4.2 miles on the ground-level route. The difference in average trip time for a vehicle on the old and new routes was multiplied by the number of vehicles benefited to give the total vehicle time saved.

The average of the minimum and maximum estimates of vehicle-minutes saved per year, given in the report, is about 61,000,000. Of this total about 54,000,000 min. were saved by passenger cars, 3,500,000 min. by light trucks and 3,500,000 min. by heavy trucks. The construction cost of the viaduct was about $19,300,000. It was assumed in the original economic study that the money value of the prospective savings should be capitalized at 6 per cent to obtain the sum that might justifiably be spent for the viaduct. Six per cent of the cost is $1,158,000, and in order to justify the construction on a basis of the minimum and maximum estimates given in the report, a vehicle-minute must be valued at 2.12 or 1.75c. Assuming 61,000,000 vehicles as the average a vehicle-minute must have a value of 1.9c. In general, passenger-car time was reduced from 14 to 6 minutes.

In discussion, Fred Lavis, consulting engineer, New York, who had charge of the original economic studies for the New Jersey state highway department, pointed out that the paper considered only one of the several savings that can be attributed to the new route. A saving of half a mile in distance has a distinct value in reduced vehicle-operating costs, and a notable saving results from the reduction in traffic congestion in the city streets. In Mr. Lavis' opinion the conjestion-relief item alone would have justified the entire $40,000,000 investment in the 13-mile road of which the viaduct is a part. S. Johannesson, designing engineer, New Jersey Highway Commission, pointed out that the study, while unusually accurate, was made during the depression and therefore was not indicative of the real value that the viaduct has. Granted a normal trend of traffic, the savings shown would have raised by 100 per cent. He also pointed out that in good times river traffic would also be increased, which would slow up trip time on the ground-level route and thus give an added relative advantage to the high-level route.

In a paper on "Economics of Highway Improvement," H. B. Shaw (North Carolina State College) discussed a method of computing economies designated as the "saving in annual expense method," by which it is possible to compare the investment to be added in making an improvement to the difference in annual service costs before and after the improvement. Using this method as a typical example, he arrived at the general conclusion that the economy of changing to a higher type of road surface depends almost exclusively upon the amount of traffic and the difference in vehicle-operating costs on the different surfaces. Annual road costs made up of maintenance, depreciation and other charges are of little consequence. The method demands that relative vehicle costs for varying surfaces be unusually accurate.

A paper entitled "Intangible Economics of Highway Transportation," by C. A. Hogentogler (Bureau of Public Roads), embodied a plea for better highway terminal facilities. That the provision of suitable parking space is essentially a matter of economics and not just a convenience for the motorist was shown effectively by charts in which the travel time from a home to a downtown destination in Washington, D. C., were shown. The charts reveal that while speed might average 20 miles an hour, time spent looking for parking space plus the time spent walking back from the parking space to the destination reduces this travel speed to about 8 miles an hour. Expenditures justi-

fied for terminal facilities can be computed on the same basis as expenditures for increased roadway, smoother riding surfaces, reduced curvature, wider bridges and better alignment, in Mr. Hogentogler's opinion.

Annual road costs

The well-known but complicated equation for average annual road costs given in the 1929 report of the committee on transportation economics was subjected to simplification by S. Johannesson, New Jersey Highway Commission, in a paper in which he presented a revised equation and recommended that in estimating the cost of construction (factor A in the equation) previous expenditures on the highway should be disregarded, it being assumed that these expenditures had previously been amortized in the service rendered. Mr. Johannesson's simplification substitutes a constant k, which takes into account both the length of life n and the rate of interest r. Showing that within the probable limits of the values of the interest rate there were no serious differences in the value of k for a given value of n, he then took the three values of k for 10, 20 and 30 years (usual lengths of life) and averaged them. The equation reduced to the following form: $C = Ar + B + 0.035E_{10} + 0.052E_{15} + 0.035E_{20}$ in which E_{10}, E_{15} and E_{20} represent the estimated replacement costs of items having an expected life of from 10 to 14, 15 to 19 and 20 to 30 years respectively.

In the paper following that of Mr. Johannesson, Prof. C. B. Breed (Massachusetts Institute of Technology) presented an unusually complete cost analysis of one typical continuous road of 27 miles involving 23 sections of different surface types and with traffic densities ranging between 870,000 and 3,700,000 vehicles per year. This paper will be reserved for more detailed consideration at a later date.

Tractive resistance

Three papers setting forth results of experiments on tractive resistance of various types of pavement as measured by coefficients of friction of automobile tires introduced the subject of operation. Prof. R. A. Moyer (Iowa State College) outlined a series of tests carried out to supplement results obtained in the pioneer studies of Dean Agg in 1923 and again in 1927. A two-wheel trailer connected to a truck with a dynamometer was used. Skidding was provoked by wetting the pavements and braking (manually) the trailer wheels. Skidding straight ahead with wheels locked, impending skidding with wheels just on the point of complete sliding and sidewise-skidding (measuring rolling friction) were investigated. A paper by Professors Karl W. Stinson and Charles P. Roberts (Ohio State University) described some similar experiments, using a recording dynamometer and hydraulic brakes on the trailer. Results closely approximated those of Professor Moyer, a few of whose conclusions follow:

1. Coefficient of friction decreased as speed increased, markedly so on wet pavements.

2. The relative resistance to skidding for wet surfaces, starting with the surfaces with the highest resistance, was as follows: high-type asphaltic pavements, tar macadams, asphalt retread and oiled gravel, untreated gravel, portland cement concrete, mineral-surfaced asphalt planks, brick, asphalt penetration macadam with soft seal coat, fine-aggregate-type asphalt plank, steel traffic plates, hard-wood plank, mud on concrete, and snow, sleet and ice-covered surfaces.

3. In the standard tests on wet surfaces at 30 miles per hour the straight-skid coefficient was 10 to 20 per cent higher than the side-skid coefficient for the same surface.

Prof. R. G. Paustian (Iowa State College) described some experiments using different apparatus—namely, a gas-electric-drive automobile. Energy required for driving a car at given speeds over various surfaces was determined from volt and ammeter readings. Rolling resistance was found to increase with speed as in other tests. Air resistance increased greatly with speed. One significant conclusion was that less power was required on rolling grades than on a flat grade.

In discussion of these papers it was pointed out by several that such results as obtained cannot be conclusive until there is a much greater volume of data obtained by a large number of investigators. E. M. Fleming (Portland Cement Association) raised the question as to whether the coefficient of friction for impending skidding was not more important than either sliding or rolling friction.

A billion a year

Tax payment by the motor vehicle was the subject of a report of an investigation currently being made by the Bureau of Public Roads. Results are not yet complete, but from the figures given it is evident that total tax payments reach one billion dollars a year, of which about 325 million come from state licensees and 513 million from state gasoline taxes. There is a great lack of uniformity in the taxing systems of the various states.

Traffic control

Consideration of means for better traffic control occupied one entire session. W. A. Van Duzer, director of traffic, Washington, D. C., described an experiment in which some 200 applicants for drivers' licenses have been given a written psychological test and a reaction time test with a novel meter apparatus. These records will be checked against accidents to these applicants, when and if they occur. In Maryland a traffic speed survey conducted last summer showed an average speed of 35.5 m.p.h. for 41,000 vehicles, with 99 per cent of the vehicles moving under 55 m.p.h. The survey was reported by Dean A. N. Johnson (University of Maryland).

A new method of securing accurate data on traffic behavior, using pictures made with a movie camera, and the development of a new formula for expressing the relations between the number of vehicles passing given points, their average rate of speed and the average spacing at which they travel were described in a paper by B. D. Greenshields, (Denison University). The camera was driven by a small motor, a constant time interval between exposures being maintained. By taking pictures of traffic at short definite intervals of time an instantaneous record of the position of the vehicle at the end of each interval was obtained. From the position of the vehicle in each of two successive pictures its velocity could be found, and from three or more pictures accelerations could be found. The process of anlysis consisted in first projecting the picture upon a white screen ruled with vertical parallel markings and adjusting the control of the lantern so that the divisions represented 5- or 10-ft. intervals along the roadway in the picture. Second, the travel or speed and the spacing between cars was taken from two pictures projected on the screen at the same time. Professor Greenshields concluded that the spacing between cars at various speeds is less than has formerly been supposed. After some experiments were made with the reaction time of drivers, a speed and spacing formula was developed in which $S = 21 + 1.1V$, where V is the velocity in miles per hour.

Concerning traffic-control methods, a paper by E. H. Holmes (Bureau of Public Roads) gave an extended analysis of the movement of traffic at an important street intersection in Washington, D. C. Vehicle-actuated control, fixed-time-interval control and complete officer control as well as uncontrolled traffic were investigated. Conclusions were that for a traffic volume of about 2,000 vehicles per hour, operation of the intersection without control incurred the least delay to traffic. Of all control methods, officer control permitted the fastest movement closely followed by the shortest fixed-time control. Also, with fixed-time control a very marked increase in delay followed lengthening of the cycle.

Two papers had direct connection with accident-control methods. H. C. Dickinson (Bureau of Standards), in a paper on "Rules of the Road in Theory and Practice," urged that all regulatory laws be based on the principle that a driver should remain in his own traffic lane, maintain a reasonably uniform speed and only change direction and

speed when he can do so without interference with other traffic. Present regulations are far too variable and much too complicated, and in many cases contribute to accidents rather than assisting in eliminating them. Dr. Walter R. Miles, Yale University, presented a paper on "Alcohol and Motor-Vehicle Drivers," in which he reported that it has been demonstrated that alcohol in the blood to an amount of 1 part in 1,000 causes inattention to external signals and environment, slower responses of eyes, hand and feet, more variable and less dependable muscular responses and increased self-assurance. Although alcohol is directly mentioned in only 7 to 10 per cent of fatal highway traffic accidents, it is believed by traffic officials that one-third of such accidents are at least partly chargeable to use of alcohol by the driver.

A. S. Loewe, General Electric Co., described experiments being made with sodium vapor lamps for highway lighting. Such lamps, although monochromatic, give excellent contrasts and no glare and thus offer much to the highway engineer. They are still in the development stage and are expensive.

Materials and construction

Curing of concrete pavements, calcium chloride in concrete, fillers for brick pavement and a study of high elastic limit steel were presented at the session on materials and construction. In a report by the project committee on the curing of concrete pavement, F. C. Lang, Minnesota highway department reviewed and evaluated the various methods in use and presented an outline of an investigation at the University of Minnesota on intermittent curing—that is, curing for a certain number of days wet and then alternate air and water curing. One of the significant findings was that fourteen days' wet curing gave a higher strength than did longer periods of curing. The future work of the committee will be concentrated on fundamentals rather than on specific investigations of various types of coatings in the hope that some basic requirements can be set down by which all curing methods can be evaluated.

L. S. Wells, Bureau of Standards, reviewed some of the work that the Calcium Chloride Association Fellowship at the Bureau of Standards is doing in investigating the effect of calcium chloride on heat evolution, setting time and compressive strength of mortars and concrete.

J. S. Crandell, University of Illinois, reporting for the committee on fillers and cushion courses for brick and block pavements, stated that experience with the use of temperature-resisting cements for fillers indicates that the sand used with the cement should have a greater percentage of fines than is ordinarily found in concrete sands, and that a longer and more thorough mixing is required because of the bituminous film on the cement. A bituminous compound known as Zorbit, consisting of a powdered asphalt mixed with a flux of such character that the mixture is fluid for a reasonable length of time, has shown minimum shrinkage quality, good adherence and ability to hold grit or other skid-proofing substances. An asphalt-rubber compound has proved wholly satisfactory in a small experimental patch of pavement at Urbana, Ill. It is more satisfactory for a lug brick pavement than for a lugless brick job.

In commenting upon attempts to remove bituminous filler from the surface of brick, Professor Crandell mentioned both whitewash and calcium chloride as suitable materials to spray on the brick. Damp whitewash is better than dry. If calcium chloride solution is used, the filler may be applied as soon as the bricks are sprayed, and the excess should be quickly scraped or peeled off. In moderate weather simply sprinkling the top of the pavement with water may prove satisfactory. Thick films are easier to remove than thin ones. G. F. Schlesinger (National Paving Brick Manufacturers Association) stated a preference for calcium chloride solutions to which a small amount of starch may be added. This should only be sprayed on the surface so that there will not be enough water present in the removed bitumen to cause foaming and fire in the kettle.

Prof. M. O. Withey, University of Wisconsin, presented the results of a paper on weathering tests on concrete by L. O. Hanson, University of Wisconsin. Four widely differing crushed limestones produced within the state were used as coarse aggregates. Alternate freezing and thawing comprised the weathering tests. Resistance of concrete to freezing and thawing was found to decrease directly as the water-cement ratio increased. Resistance of the concrete was found to be directly reflected in the quality of the coarse aggregates. Sixty cycles of freezing and thawing with partial immersion proved a severe weathering test.

An unusually complete report covering a preliminary study of the use of high elastic limit steel in concrete reinforcement was given by H. J. Gilkey, Iowa State College. The report reviewed prior investigations of the problem and presented original studies bearing upon design procedure and relative economy in using high elastic limit reinforcement in ordinary construction. Among the conclusions were the following: that high elastic limit reinforcement in the form of either hot-rolled high-carbon rods or cold-drawn low-carbon wire is sufficiently uniform to be used with a working stress of either 25,000 or 30,000 lb. per sq.in.; that with such steel there is need for improved anchorage of all steel as well as for adequate web reinforcement; and that the dangers of concrete cracks and consequent steel corrosion be among the further problems to be studied.

Design and maintenance

Three papers on design were concerned with as many field experiments. A paper on an experimental brick road, by O. W. Merrell (director, Ohio state highway department), and one on cement macadam pavement experiments by E. M. Fleming (Portland Cement Association), will be reserved for future treatment in more detail. In Rhode Island a study of cracks in sheet asphalt pavements on concrete bases has recently been carried out and was reported upon by John V. Keily, of the state board of public roads. Concrete bases with various arrangements of expansion joints, dummy joints and contraction joints were constructed. Based on the experience with these trial sections, Mr. Keily made the following suggestions: (1) That dummy joints be replaced by light deformed steel contraction joints spiked to the subgrade and left in place. These joints should be sufficiently strong to form an effective key between sections and extend up at least 1 in. into the binder course, to straighten out surface cracks. (2) Transverse contraction joints should be placed at intervals of not more than 20 ft., so as to form relatively fine cracks which, if reproduced in the asphalt surface, will heal under summer traffic and require little or no maintenance in winter. (3) Light deformed metal strips should be used for longitudinal joints to transfer loads between lanes. (4) Expansion joints should be eliminated from all concrete base construction used under asphalt pavement.

W. H. Root (Iowa highway commission) outlined an experimental project on 4 miles of road near Ames, Iowa. Without exception, asphalt crack fillers behaved satisfactorily in that they were unaffected by traffic. Asphalt cutbacks, however, picked up badly on the tires of passing cars. A rather heavy sanding given the crack immediately after pouring made this material more suitable. An asphalt emulsion behaved similarly except that it spattered more than the cutback and failed to respond satisfactorily to sand treatment. The report concluded that asphalt of the general character used—that is, with a penetration of around 100 at 25 deg. C. —or a fairly soft tar with a float test of around 112 makes satisfactory crack filler.

In his paper on "Treatment of Icy Pavements," B. C. Tiney stated that the committee on maintenance recommends the application of calcium chloride-treated sand or cinders applied at the rate of 2 lb. per square yard of pavement surface. Where ice must be removed as on city streets, 2 lb. of calcium chloride per square yard of surface can be used; the resulting slush should be removed as soon as practicable.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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Today's Road

TODAY'S perfected main road represents a summit attained in the rapid climb of the highway upward from the fenced trail. It is now a designed transportation agency in a measure never previously realized. The change is great from even a brief year ago. From the fundamental elements of roadway to the details of traveled surface, today's perfected main road expresses the application of engineering science and technique to a definite purpose. It is the product of the laboratory and the machire as much as is the frame of steel for an Empire State Building or a San Francisco Bay Bridge. New materials and new inventions will carry the main road to loftier peaks by adding refinement and precision of detail to the fundamental plan now perfected. The elements of this plan, as outlined in this issue, should be a part of the knowledge of every engineer.

A Power Policy

IN A memorable address before the American Institute of Electrical Engineers on Dec. 4 the chairman of the Tennessee Valley Authority, Arthur E. Morgan, indicated that body's attitude toward power development and distribution more clearly than in any previous statement. It has been known that the Authority desired to assure that complete electric service would be provided to all parts of the Valley, that this should be done at the lowest rates that would cover all costs, and that it counted on a large increase in the per capita use of power. These points Mr. Morgan restated and emphasized. His new contribution was the statement that unified operation and ownership is held essential to attainment of these objectives, and that this unified control must inevitably be through public ownership. The latter point, which is the essential one, is obviously of sensational moment. It is founded on the conviction that where a great geographical province has a unified power system and thus is subject to power monopoly, its welfare and even its economic existence are at the mercy of the interests in control of the power system. Such control, Mr. Morgan asserted, cannot be entrusted to a private profit group but must be administered by public agencies. Interpreting this statement, it means that public-utility regulation has failed. The future will have to demonstrate whether or not the TVA plan is the inevitable alternative.

The Primary Job

WHILE the TVA is under discussion it is proper to record that its work on Cove Creek Dam (yclept Norris Dam) and Dam No. 3 (General Joe Wheeler Dam) is going forward with driving energy. These two undertakings—one of them necessary, the other a waste investment for the present but undertaken at the President's dictation to put money in circulation in northern Alabama—are being pushed at top speed. By present indications Cove Creek will make a record rivaling that of Boulder Dam. In little more than two months activity has appeared on all parts of the site and surroundings, approach roads and bridges have been built, the cofferdam is half completed, a quarry is started, a remarkable camp constructed, and abutment excavation is well under way. Nearly 2,000 men are at work on the site, and many more in the supply establishments here and there that are the necessary background of every construction undertaking. At Dam No. 3, near Florence, Ala., work started only recently, but already it is proceeding at high speed, and the power-house site will soon be ringed in by its cofferdam. Thus the TVA is going at its first job, that of providing employment, with brilliant energy. If similar drive and skill are applied to the second problem, the industrial and agricultural development of the Valley, the great experiment can hardly fail to succeed.

Control Survey Extension

WORD of the proposed extension of the control survey network of the U. S. Coast & Geodetic Survey as a relief measure under the Civil Works Administration comes as welcome news to the many unemployed engineers throughout the country. While the pay is small—generally less than that set as a minimum for skilled mechanics under the PWA scale — it is much better than nothing at all, and it is actual pay for actual, worth-while professional work. Until now engineers have been stepchildren in relief work, except in a few cities where a sincere effort has been made to put them in supervisory positions. The one bright light has been the U. S. Coast & Geodetic Survey. By pressing for a continuation of its regular work, supported by engineers who have sought out state funds to supplement the federal money, the Survey has provided many jobs. Now there are to be more. The proposed work is supplemental to the main network of the Survey; it will consist of adding intermediate lines of plane coordinates and levels between the 25-mile spaced network of the main control system. Such intermediate lines are needed in order to make it possible for engineers to tie their surveys into the main system without going to the expense of running lines as far sometimes as 12½ miles to reach the main control network.

Lessons From Disaster

A FIRE which destroyed a group of oil-storage tanks and took three lives in Tiverton, R. I., is the first major disaster that can be attributed to failure of a welded joint. The weld was in a new tank that collapsed when it was under a test load of salt water; the fire was an unfortunate corollary of the flood of water that was released. It is comforting to learn that the weld failure apparently was due to obvious mistreatment in the form of calking or patching the joint while under heavy stress rather than to an inherent fault in the welding process itself. A report on the failure, published on another page of this issue, also suggests defective welding as a possible contributing cause of failure and urges the development of some practical means of field inspection of weld-metal structure, citing the X-ray. The desir-

ability of such inspection methods cannot be questioned. But recognition of the need for better inspection should not be allowed to detract from the real lessons to be learned from the failure. As a matter of fact, by prequalification of welders, supervision of the welding and careful surface examination, good welds may invariably be secured. The Tiverton tank failure has a double significance. First, it points unmistakably to the need for unit stresses in oil-storage tank design that are dictated by safety requirements and not by commercial competition. Second, it emphasizes the doctrine that a welded joint should not be calked or rewelded when under heavy stress. Human safety, security of plant investment and the improvement of a valuable structural tool depend henceforth upon heeding these lessons born of disaster.

On What Course?

NOT SINCE early summer has the question of assuring active progress of recovery been as acute as now. Six months ago the problem was how employment on a large scale could be produced quickly; today the problem is how to maintain existing employment and further increase it to the point of spontaneous recovery. Public works and civil works organizations both will soon reach the end of their purse. What course is to be charted beyond that point?

There should be no doubt as to the importance of this question. The record of millions of idle workers returned to wage-earning jobs makes a solid case for the recovery activities. What has thus been accomplished—unfortunately too slowly to initiate the spontaneous progress of recovery that was intended—must obviously be continued.

At the moment Civil Works is most prominently in the public eye. Nearly two million men have found jobs on civil works projects, and more will soon be employed. The workers are off "welfare" and are earning fair wages through their labor on useful betterments. This is real relief, the more welcome after the PWA's months of ineffective efforts to get construction employment started.

Far-reaching mitigation of the season's rigors is thus achieved—though on a relief basis often but thinly disguised. Against this accomplishment must be set off the fact that it means complete federalization of responsibility, financing and control. It is the first instance within memory of substantial abdication of human responsibility by cities and counties, and to some extent by the states. A system that leads to such a result ought not to be continued.

Temporary establishment of this system was made necessary, as is universally recognized, by the PWA's failure to fulfill its primary purpose of employing several million workers by winter. As could be seen before summer ended, politics, patronage and bureaucratic centralization aided by a narrow legal and financial outlook slowed it up. The cause of quick employment suffered further when large funds were early transferred to regular government operation and when long-time projects and even inherently unsound schemes were authorized—the long-embattled Grand Coulee undertaking and the Casper irrigation project as instances. But the PWA, if slow, organized well, and finally did set in action a great amount of needed local construction work. It is now accumulating momentum, and by spring its effects will begin to tell.

Already, however, its resources are near exhaustion. The great fund of $3,300,000,000 was poured out too slowly to induce that vigorous flow of business lifeblood which its rapid utilization was intended to produce; but if the effort is continued and made more rapid in action, an increasing activation of normal industry is certain to result. Shall the work, then, come to an end before it is effective? There is real danger that this may happen, for the municipal apathy born of the PWA's slowness to act and reinforced by the attractiveness of the CWA's 100 per cent disbursement as contrasted with the 30 per cent PWA grants seriously endangers the active partcipation by cities in the PWA program. This effect is strengthened by the rigid, ill-devised labor policy of the PWA, by failure to put the impetus of nationally inspired enthusiasm behind the program and by the difficulty of keeping the CWA operations free of regular construction projects.

In choosing between the two forms of campaign, the vital criterion is that Civil Works is only relief, not a step toward recovery. It paralyzes local initiative, which must remain the ultimate reliance. And even more immediately important, it does nothing to restore life-giving flow in the channels of industry and trade. Recovery cannot be attained in this way. As before, it must be sought by intensive prosecution of public works.

Congress is almost sure to see that the public works construction re-employment fund is increased. In doing so, however, it should inject into its administration something of the speed of Civil Works. These are the fundamentals of the new program:

That it be sound, free from pork and from city pauperization.

That its operations be in useful and needed work in the public interest.

That it bring into action the structure and machinery of industry and trade—for unless these be revised there can be no lasting recovery.

And finally, most important of all, that it be quick in action.

Certain it is that neither the PWA nor the CWA as now set up can meet these requirements. A reconstructed organization and principle of administration is inevitable, following the broad outlines of the PWA but freed of its delays and restraints. The alternative is wholly federal conduct of a broadly conceived plan of improvement construction, both local and national, with entire elimination of the local factor, on some such basis as that laid down in the remarkable survey of construction needs just completed at Washington and briefly reported on another page. But, aside from its directly national elements this plan represents so basic a departure from existing governmental principle as to be tolerable only as last resort. Until shown to be incapable of being made effective, the PWA system of financing construction with local participation, strengthened by embodying the fundamental principles just stated, stands as the only safe and sure course of recovery.

NEWS OF THE WEEK

City of New York Get $23,160,000 For Subway Work

ALLOTMENT of $23,160,000 as a combined loan and grant to New York City for completing construction of the municipally-owned Independent Subway has been approved by the PWA, provided that by Feb. 1 the city is able to furnish good security and satisfactory assurance that its budget will be balanced at an early date; subject also to execution of a contract acceptable to the PWA. "Now that the voters of New York have selected new leadership we," said Secretary Ickes, "are willing to do everything possible to rehabilitate greater New York. Accordingly, we have been studying this situation intensively and I am confident that with the cooperation of Mayor LaGuardia we will be able to agree upon a financial plan that will be acceptable to the city and justify the Public Works Administration in finally approving the loan and grant desired to build this subway."

Large grant included

The grant is for 30 per cent of the labor and materials costs, estimated at $18,300,000. The balance, to be repaid serially by 1963, will be secured by the corporate stock of New York City. The city has spent $550,000,000 on the subway system, including $140,000,000 on the sections to be completed and equipped with PWA assistance. Work to be done under the allotment includes completion of subway passenger stations, including tile and other finish, plumbing, controls, escalators, turnstiles and other equipment; laying tracks and third rails throughout tunnels and inspection yards; installing drainage and ventilating equipment; signals and switching operating mechanisms; cables and equipment for transmission and control of power and light throughout the project; construction of power substation and installing necessary mechanical and electrical equipment; construction and equipment of car inspection sheds and storage yards.

Work under contract

Bids on one-fourth of the work to be done which were received prior to passage of the Recovery Act are not subject to the 30-hr. week and other requirements but some bidders to whom contracts have been awarded have signified willingness to accept contracts with such a modification. Drawings and specifications on another quarter of the project are ready for contract letting and work is in progress on plans and specifications for the remainder.

The city originally applied for $25,500,000, but the PWA eliminated $1,530,000 for a connection with the Rockaway Division of the Long Island Railroad because the necessary rights from the railroad have not yet been acquired. The city's estimate for interest during construction was reduced from $1,790,000 to $980,000. Funds for the Rockaway connection can be applied for separately if the city negotiates an agreement with the Long Island R.R.

Other allotments approved Dec. 12 include $1,940,559 to the Treasury Department for buildings as follows: new assay office, San Francisco, $780,000; federal building, Phoenix, $635,599; federal building, Mangum, Okla. $45,000; remodelling the Denver mint, $440,000 and remodelling present Phoenix federal building $40,000.

Planning work starts

New Hampshire is the first state to avail itself of technical assistance furnished by the PWA for preparation of a state plan. Governor John G. Winant will appoint a state planning board and will ask the legislature to authorize its establishment on a continuing basis. Two consultants will be assigned by the PWA National Planning Board of assist state board.

PITTSBURGH BRIDGE COLLAPSES UNDER HEAVY LOAD

Two street-railway work cars, weighing 60 and 40 tons respectively, and a 5-ton oil truck proved too great a load for the Braddock Ave. approach ramp to the old Rankin Bridge over the Monongahela River in Pittsburgh, with the result shown in the above view. There were no fatalities from the accident, which occurred on Dec. 7, and only four persons were injured. Six spans were involved but principal failure occurred in the laced-channel columns and deck trusses of an 80-ft. span over the main line tracks of the B. & O. R.R. Present indications are that the collapse was initiated by column buckling and an investigation is now under way to determine the exact cause. The bridge, built in 1897 as a toll structure, was purchased by Allegheny County in 1924. It had been repaired last year after an explosion, occurring nearby, had damaged it by shock and fire. A new structure for the site had been included among the projects for which the county had applied to the PWA for a loan. Partly for this reason, it is said, the wrecked span will not be rebuilt. As a direct result of the accident, the county commissioners have ordered an inspection of ten other county bridges.

Construction Code Reported Progressing Toward Approval

REVISION of the integrated construction code in the form worked out two weeks ago by D. R. Richberg, general counsel of the NRA, in cooperation with the code committee of the Construction League, was completed last week and has since been under discussion by the general committee and the code committees of the component groups of the industry. As we go to press it is reported that these discusions are progressing without serious points of difference, and there is believed to be prospect of early action on the code as a whole and a number of its chapters covering major divisions of the industry, including general contracting and several subcontracting divisions.

In the present form of code the entire industry is covered by a single document containing in its first chapter general definitions, basic employment limits, administrative provisions and clauses governing competitive bidding practices; each subsequent chapter is to cover a division of the industry and is to include the specific definitions, divisional code authority provisions and trade practice rules applicable to that division.

The present labor clauses contemplate that regional or local agreements may be arrived at in any division of the industry by representative collective bargaining. When such an agreement is approved by the President its violation shall be deemed prima facie unfair competition. Joint employer-employee boards set up by the Administrator shall investigate complaints of unfair competition. Where no such agreement has been approved, a 40c. wage minimum and 40 to 48-hr. week maximum applies.

A code authority chosen by sponsor organizations of the code is to supervise operations of the system in general, but specific supervision of rules and bidding practices is placed in the hands of divisional code authorities.

Golden Gate Bridge Directors Vote for High Silica Cement

By a vote of 9 to 3 the directors of the Golden Gate Bridge and Highway District voted to back up the judgment of its engineers and consultants on the matter of using high silica cement in the San Francisco pier of the Golden Gate bridge. Suit had been brought by the Pacific Portland Cement Co. to prevent the use of the high silica product. The directors authorized Joseph B. Strauss, chief engineer, to specify high silica cement for the San Francisco pier and also stated that "whenever in his judgment it is to the best interest of the district that said high silica cement be used in any of the construction work of the Golden Gate Bridge and Highway District."

Work Started on Flood Project On Rio Grande at Nogales

The Department of State on Nov. 22 issued instructions to Commissioner L. M. Lawson of the International Boundary Commission to commence work on the floodway through the towns of Nogales, Sonora, and Nogales, Ariz. On Nov. 12 the American and Mexican commissioners signed a joint report embodying a plan for the construction of an additional floodway through these towns and, subsequently, the Public Works Administration allotted the sum of $433,000 for the portion of the work to be performed in Arizona.

The Public Works Administration also has allotted $1,500,000 for emergency flood control work on the lower Rio Grande which is to be done by the American section of the International Boundary Commission entirely in the United States. This work does not require a formal treaty with Mexico although plans were developed jointly with the Mexican section. They provide that each section shall perform the necessary work located in its respective territory for disposal of the flood waters which reach the lower Rio Grande. J. L. Lytel is project engineer on this work with headquarters at San Benito, Texas.

What is known as the Rio Grande rectification project at El Paso, and which project includes the rectification of the Rio Grande below El Paso for a distance of 88 miles and a flood retention dam on the Rio Grande 100 miles above El Paso, is covered by a formal treaty between the United States and Mexico because it involves changes in the international boundary line below El Paso. The treaty between the two countries was signed Feb. 1 of this year at Mexico City. The Senate of the United States ratified this treaty on April 25, and on Sept. 13 the Mexican Senate took similar action. The exchange of ratifications is expected within a short time. The cost of the portion of the work to be assumed by the United States is $5,256,624. The engineering plans for this project were detailed in *Engineering News-Record*, Feb. 16, 1933, p. 226.

Deep Trans-Bay Caisson Landed

Successful landing of Caisson 6W of the Trans-Bay Bridge at San Francisco, which is located in deeper water than any of the others, was accomplished on Dec. 12. This caisson, like the other main caissons of the bridge west of Goat Island, is an open-dredging caisson equipped with pockets closed at the top by air domes for ready control of landing and sinking, a new development in the caisson field. The caisson was landed without incident, and was sunk several feet into the mud of the Bay bottom, within 6 in. of true position. The Trans-Bay Construction Co., contractor for the caisson, reported that "control of the landing with air was positive and satisfactory."

This caisson is to form the foundation of the east main tower of the double suspension bridge west of Goat Island, being the pier located nearest the island, and is 74½x127 ft. in horizontal dimensions. The water depth at the site is 105 ft. from low-water-level to mud, and the caisson is to go down to rock at 170 ft. below low water.

Contract Let for Structures of Syracuse Track Elevation

Contract for construction of the embankment, retaining walls and structures to provide street underpasses in connection with the New York Central track elevation at Syracuse, N. Y., has been let by the railroad company to the Walsh Construction Co., Syracuse, N. Y., on a bid of $4,021,097. Additional work costing about $3,500,000 was begun some time ago by the railroad company on a day-labor basis under the direction of the company's own construction forces.

Boston Professional Engineers Organize for Code Work

There has been formed in Boston an emergency organization of professional engineers in private practice to study the development of the code for the professional engineers division of the construction industry and other matters of professional interest. Whether the organization will be of a permanent nature has not been determined. Alfred Kellogg has been made chairman to act for one year unless earlier released and he has been given authority to appoint an executive committee which also may act as a code committee. About 40 engineering organizations were represented at the organization meeting.

The meeting took up discussion of the code as now written and has prepared recommendations to be made to the code committee of the Construction League. Subjects covered are those of setting up a control committee composed entirely of professional engineers, the sponsoring of the code by organizations not truly representative of the practicing professional engineer, making the code inclusive of all professional engineering work, limitation of the definition of the functions of an engineer, and hours of work.

Edward B. Richardson, 12 Pearl St., Boston, is secretary of the organization.

California Earthquake Law Closes Five Berkeley Schools

Five schools in Berkeley, California, were closed for repairs and strengthening when declared to be below the provisions of the new state law requiring all school buildings to be earthquake resistant. Four more San Francisco schools are under study following the closing of three schools recently. A survey of Oakland schools is under way but has not reached a point where recommendations can be made.

A recent ruling by the state attorney general has held that members of school boards throughout the state are liable to criminal prosecution for manslaughter under the state law if deaths occur in school buildings which have been ruled unsafe from seismic shock by the state architectural department. This ruling will have a definite effect to speed any rehabilitation which may be required by an unfavorable ruling of the engineers from the state department, in regard to the safety of any school structure.

The board of education in Berkeley has voted $50,000 to construct temporary buildings to house the 3,000 children affected by the closing of the five schools. The condemned buildings represent a total investment of about $1,250,000. A Federal loan and grant of about $4,000,000 may be sought for a rebuilding program.

Navy Yard and Dock Work Rapidly Getting Under Way

The Bureau of Yards and Docks of the U. S. Navy has placed under contract, or has started by station forces, emergency public works projects exceeding $14,400,000, and has called for bids on additional projects amounting to $8,200,000, most of which is expected to be under contract by the end of the year. The most important project is a new ship repair base at the Navy Yard at Pearl Harbor in Hawaii. A contract for $2,789,000 for this work has been awarded to the Hawaiian Dredging Co. of Honolulu.

WORK UNDER WAY ON NORRIS DAM ON THE CLINCH RIVER

The present stage of work on Norris Dam at Cove Creek on the Clinch River, is shown in the accompanying photograph. In the left center land is being cleared preparatory to excavating for the one abutment of the dam. In the lower right corner the construction bridge across the river below the dam is being erected. Construction of the dam is being carried forward by the Tennessee Valley Authority.

Second Large Loan Made to Chicago for Sanitary Work

AN additional allotment of $33,948,000, a combined loan and grant, has been made to the Sanitary District of Chicago by the Public Works Administration. This, with the loan of $8,000,000 previously authorized, will bring the total amount for the sanitary district up to nearly $42,000,000.

The allotment is made on the basis of securing the government by general obligation bonds of the district. In addition to the bonds, the district has agreed to secure legislation authorizing the fixing of charges for handling of trade waste in accordance with the use made of the sewage system. It has agreed to pledge such revenues and all revenues from the sale of electric current as security for the bonds being turned over to the government.

The work to be covered by the allotment is the construction of four sections of the West Side intercepting sewer, the completion of the Calumet treatment works the construction of four of the Calumet intercepting sewers, three additional sections of the West Side intercepting sewer and for the construction of the pumping station, blower house, two batteries of aeration tanks and necessary connecting conduits for the West and Southwest Side sewage treatment works. All contracts will be let and disbursements made under supervision of engineers to be appointed by the government, and the treatment work will be constructed in accordance with an engineering study and review, as noted in our issue of last week. In the event that contracts are let or disbursements made without government approval, the districts will not be entitled to the grant, estimated at about $8,845,000.

The money now available will finance the district's program for the next two years.

Other non-federal loans

The largest number of non-federal loans and grants yet approved was announced by the PWA last week, a total of 129 in two separate groups. Details are given in the accompanying table. Outside of the $33,948,000 combined loan and grant to Chicago, which is included in the list of non-federal loans, other large loans include $2,472,000 to the Brownsville Navigation District, Cameron County, Texas, for the construction of a ship canal 100 ft. wide, 25 ft. deep and about 15 miles long. The loan will be secured by general obligation bonds at 5½ per cent interest payable from unlimited ad valorem taxes. Interest in excess of 4 per cent will be refunded to the applicants. A combined loan and grant to the county of Los Angeles of $2,115,200 has been made for the construction of a 13-story county office building.

Mountain parkway

An allotment of $4,000,000 has been made to the Office of National Parks, Buildings and Reservations to extend construction of a national parkway drive from the Shenandoah National Park in Virginia to the Great Smoky Mountains National Park in North Carolina and Tennessee. The length of the parkway from the southern point of the Shenandoah National Park to the northern point of the Great Smoky Mountains Park will be about 350 miles. Its exact route has not been determined, but preliminary plans contemplate a drive that in general will follow the Southern Appalachian Mountain range. The states of Virginia, Tennessee and North Carolina through which the parkway will pass have agreed to acquire a 200-ft. right of way except where it passes through federal property.

The Bureau of Lighthouses has been allotted $149,600 for the establishment of navigation aids at fourteen points throughout the country. An additional allotment of $5,000,000 has been made to the Soil Erosion Service of the Department of Interior to extend its activities. The work of this service was noted in our issue of Nov. 30, p. 644.

Federal building work

The procurement division of the Treasury Department has been allotted $1,750,000 for the construction of an addition to the federal warehouse in Washington, D. C.;

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Locality	Loan and Grant or Grant	Type	Man-Months Work Provided	Amount
Neuces County Navigation Dist., Texas	L. & G.	Ship canal	600	$200,000
Peoria, Ill.	L. & G.	Sewers	450	102,000
Peoria, Ill.	L. & G.	Sewers	7,200	920,000
Huron Rd. Hospital (private), Cleveland, Ohio	L.	Hospital	760	336,000
Larimore, N. D.	L. & G.	School	270	20,000
Warren, R. I.	L. & G.	Sewer	275	50,000
Two Rivers, Wis.	L. & G.	Water	546	143,000
Ripley, W. Va.	L. & G.	Water	210	37,000
Greenville, S. C.	L. & G.	Sewer	1,300	205,000
Greenville, S. C.	L. & G.	Sewer	3,200	415,000
Louisville, Ohio	L. & G.	Waterworks	180	55,000
Fergus Falls, Minn.	L. & G.	Sewers	960	289,000
Matagorda County, Texas	L. & G.	Roads	600	104,500
East Providence, R. I.	L. & G.	School	288	101,428
East Providence, R. I.	L. & G.	School	720	174,500
Aurora, Ind.	L. & G.	School	312	90,400
Austin, Texas	L. & G.	Water System	875	400,000
Plainview, Texas	L. & G.	Sewage	54	9,000
Wilmette, Ill.	L. & G.	Water	400	117,000
Los Angeles County, Calif.	L. & G.	Office Bldg.	5,850	2,115,200
Rosenberg, Texas	L. & G	Water	75	35,000
Ashby, Minn.	L. & G	Waterworks	120	25,000
Mt. Morris, N. Y.	L. & G.	Water	120	45,000
Buttonwillow, Calif.	L. & G.	School	40	11,500
Burbank, Calif.	L. & G.	Sewer	900	127,000
Riverside County, Calif.	L. & G.	City Hall	60	14,000
Cyrus, Minn.	G.	Waterworks	160	5,000
Tehachapi, Calif.	L. & G.	School	165	40,000
Pawnee, Okla.	L. & G.	Sewage	200	50,000
Pawnee, Okla.	L. & G.	Roads	60	8,000
State of Connecticut	G.	Streets	70	4,800
Kansas City, Mo.	G.	School	6,450	500,000
State of Missouri	G.	Bridges	298	21,100
Titonka, Iowa	G.	Sewers	20	950
Lehigh County, Pa.	G.	School	140	12,200
Alameda County, Calif.	G.	Courthouse	6,730	462,000
Fresno, Calif.	G.	Waterworks	52	25,500
St. Louis County, Mo.	G.	Hospital	1,275	70,200
North Providence, R. I.	L. & G.	Fire Station	15	6,000
Morning Sun, Iowa	G.	Public Library	20	600
Ottumwa, Iowa	G.	Water Mains	34	2,000
Kimballton, Iowa	G.	Waterworks	15	800
Sauk Centre, Minn.	G.	Sewage	240	13,000
Rake, Iowa	G.	School	100	8,200
Williamstown, Mass.	G.	Sewer	250	9,000
St. Clair, Mich.	G.	Sewer	50	4,000
Mound, Minn.	L. & G.	Waterworks	180	61,000
Memphis, Tenn.	L. & G.	River Front Drive	500	100,000
Memphis, Tenn.	L. & G.	Adm. Building	1,344	522,000
Worthington, Ky.	G.	Highway	20	1,500
Kaukauna, Wis.	G.	Water	54	5,000
McFarland, Kan.	G.	School Bldg.	40	4,000
St. Louis, Mo.	G.	Park impr.	1,536	119,000
Bridgeport, West Va.	L. & G.	Waterworks	60	13,000
Grand Haven, Mich.	L. & G.	Power	60	95,000
Sanborn, Minn.	G.	School	12	2,000
Galveston County, Texas	G.	Roads	180	10,000
Peru, Ill.	G.	Waterworks	420	19,000
Newport, R. I.	L. & G.	Sewers	1,080	168,000
University of Minnesota, Minneapolis, Minn.	G.	Building	105	9,000
Custer County, Okla.	G.	Courthouse	315	28,000
St. Clair, Mich.	G.	Streets	38	2,000
Anderson County, Kan.	G.	Bridges	75	5,000
State of New York	G.	Auburn Prison	2,760	226,000
State of New York	G.	Matteawan Hospital	1,800	146,000
State of New York	G.	Dormitories, Albion	3,060	262,000
Brownsville Nav. Dist., Texas	L. & G.	Ship Channel	9,900	2,472,000
Middlesboro, Ky.	L. & G.	Power Plant	280	328,000
Guin, Ala.	L. & G.	Waterworks	1,120	79,000
Winooski, Vt.	L. & G.	City Work	450	30,000
Benson, Vt.	G.	School	45	2,100
Nashua, N. H. (amendment)	L. & G.	Streets	1,650	122,000
Oldenburg, Ind.	L. & G.	Water	200	36,000
Somersworth, N. H.	L. & G.	Waterworks	300	60,000
Hammond, Ill.	L. & G.	Water	160	34,000
St. Johnsbury, Vt.	L. & G.	Waterworks	450	128,000
Highland Park, Mich.	G.	Streets	500	16,000
Batavia, Ill.	L. & G.	Sewage	420	100,000
Croton-On-Hudson, N. Y.	L. & G.	Waterworks	350	115,000
Canajoharie, N. Y.	L. & G.	Sewage	220	55,000
Harris County, Texas	L. & G.	Road Impr.	120	35,654
Sault Ste. Marie, Mich.	L. & G.	Street Impr.	100	12,677
Sault Ste. Marie, Mich.	L. & G.	Street Impr.	780	63,838
Sault Ste. Marie, Mich.	L. & G.	Sewer 200	200	28,000
Tipton, Mo.	L. & G.	Sewer	90	43,000
Tipton, Mo.	L. & G.	Water	210	48,000
Woodstock, Ill.	L. & G.	Waterworks Impr.	280	64,000

(Continued in adjoining column)

$140,000 has been allotted to reconditioning the fourth floor of the Treasury Department Building and sums totalling $33,000 have been awarded for other federal building work.

Loans rescinded

Allotments of funds for non-federal work in Mount Ranier, Md., and for two projects in Barre, Vt., have been rescinded by the PWA because legal difficulties have made it impossible to complete the contract.

Railroad equipment loans

Railroad equipment loans totaling $41,807,500 have been authorized by the Public Works Administration, subject to the negotiation of satisfactory contracts. Allotments of $18,065,000 to the Chesapeake & Ohio, $11,964,000 to the Erie, $5,028,000 to the Nickel Plate and $1,250,000 to the Northern Pacific will be used for purchase of 12,775 freight cars, 167 passenger cars and 30 locomotives. The Northern Pacific has received bids, the Erie and Nickel Plate have requested bids and the C. & O. will do so soon. Loans will be secured by 4 per cent 15-year equipment trust certificates maturing semi-annually. No interest will be charged the first year.

Loans of $3,500,000 to the New York, New Haven & Hartford, and of $2,000,000 to the Lehigh Valley, authorized last week, will be used for repairing and rebuilding cars and equipment in their own shops.

Engineer inspectors named

The following have been appointed state engineer inspectors, with headquarters in the offices of the PWA state engineers:

Iowa: C. P. Stowitz, Des Moines.

Wisconsin-Minnesota: J. H. Watson, St. Paul.

Massachusetts: J. A. Garrod, Boston.

Maryland: H. S. Shryock, Baltimore.

Connecticut-Rhode Island: F. I. Carew, Bridgeport.

Henry M. Wallace has been appointed to the Michigan advisory board to succeed Murray D. Van Wagoner, resigned.

Army Engineers to Restudy Plans for Canal Across Florida

President Roosevelt has instructed Army Engineers to restudy on the basis of providing a 30-ft. channel the proposed plan for constructing a waterway across the Florida Peninsula. It has been learned that the President felt that a 35-ft. channel would be too expensive and that there was no real necessity for such a depth at this time. Few ships of a size that would require a 35-ft. channel would utilize the canal.

A description of the proposed canal was published in our issue of Nov. 9, p. 578.

Suit Against Quebec Engineer Dismissed on Legal Technicality

A suit brought by the Quebec Association of Architects against James Ruddick, an engineer, over the design of two buildings, was dismissed on a technicality in a judgment handed down in the Superior Court of Quebec on Dec. 1 by Justice Marchand. It was claimed in the suit that Mr. Ruddick had made plans for two buildings in the Province of Quebec, although not an architect, and not a member of the Provincial Association of Architects, which association claims for its members the sole legal right to prepare plans for the construction of buildings within the Province.

The case was not considered on its merits, but was dismissed on the ground that according to law the action must be brought within one year of the alleged offense, and plans for both buildings were prepared and submitted more than a year ago.

As the case was of significance to engineers in building work in the Province of Quebec, the Corporation of Professional Engineers of the Province of Quebec took up the case in behalf of Mr. Ruddick, who is a member of that organization.

New Jersey Acts to Aid Cities Seeking Funds from the PWA

Among the legislation passed by the legislature of the state of New Jersey at its present special session are bills enabling counties, municipalities and school districts to borrow money from the Public Works Administration beyond their debt limit as now set by the state constitution. While such borrowing is exempted from the constitutional debt limit, it must be included in the future in computing the debt limit for other loans.

In order to speed up work under the PWA program, the state highway commission has been authorized to award contracts within one week after the call for bids instead of three weeks, as heretofore required.

The legislature, before it recessed on Dec. 6, approved the creation of a state housing authority to obtain federal funds for low-cost housing and slum elimination. Another new state law, passed previously, vests supervision of limited-dividend housing companies in the state public utility commission.

Additional Sewage Plant Recommended for Toronto

Construction of a large new sewage disposal plant has been recommended to the city council of Toronto, Ont., Canada, in a report prepared jointly by the firm of Metcalf & Eddy, Boston, and Gore, Nasmith & Storrie of Toronto. The entire project covered by the report would cost about $26,000,000.

The report recommends that the development be laid out to take care of the sewage from the area known as the Greater Toronto Sewerage District, that a population of 877,000 in 1948 and one of 1,564,000 by 1970 be planned for, that all flows up to two and one-half times the average daily flow be conveyed to the treatment plant, that complete treatment be given to all flows up to one and one-half times the average and the surplus be treated by sedimentation only. Elimination of the existing Eastern Avenue sewage-treatment plant is called for, also provision for pumping the sewage coming to that plant to a new sewage-treatment plant at the mouth of Highland Creek in Scarborough Township, close to Lake Ontario, from which an outfall conduit will lead into Lake Ontario. The new pumping station adjoining the site of the Eastern Avenue plant is estimated to cost $859,000, an outfall sewer from the pumping station to the proposed Highland Creek plant to cost $9,374,000; the plant itself $9,435,000, and the outlet conduit $760,000. Intercepting sewers within the city would cost $5,411,000, and those to serve the outlying district, $3,745,000.

The treatment process would consist of preliminary sedimentation, activated-sludge treatment of the settled sewage, and digestion and mechanical dewatering of the sludge. The new plant would be 11 miles east of the existing plant. Its discharge would be carried into the lake a distance of 4,480 ft. for discharge through a diffusing system about 34 ft. deep. It is estimated that six years would be required to build the plant and put it in shape for operation.

Oklahoma A. & M. College	L. & G.	School Addition	1,400	450,000
Salem, W. Va.	L. & G.	Sewage	380	75,000
Ordway, Colo.	L. & G.	Waterworks Impr.	425	90,000
New Wilmington, Pa.	L. & G.	Sewer	18	5,000
Weslaco, Texas	L. & G.	Sewage	300	50,000
Lake Forest, Ill.	L. & G.	Water Impr.	1,920	338,000
Winston-Salem, N. C.	L. & G.	Sewer	2,304	250,000
Pelham, N. Y.	L. & G.	Water	600	175,000
Fayetteville, Ohio	L. & G.	School Bldg.	288	84,000
Lindsberg, Kan.	L. & G.	Sewage	120	35,000
Farmersville, Tex.	L. & G.	Waterworks	390	51,000
Charlotte, N. C.	L. & G.	Fire Hydrants	90	36,000
Charlotte, N. C.	L. & G.	Fire Alarm	50	31,000
Charlotte, N. C.	L. & G.	Sewage	720	89,000
Charlotte, N. C.	L. & G.	Waterworks Impr.	390	60,000
Huron, S. D.	L. & G.	Street Impr.	520	107,000
Charlotte, N. C.	L. & G.	Sewers	1,260	130,000
Mt. Morris, N. Y.	L. & G.	Sewers	90	15,000
West Warwick, R. I.	L. & G.	Sewers	2,544	600,000
Mitchell, S. D.	L. & G.	Sewers	300	75,500
Worthington, Ohio	L. & G.	Waterworks	75	18,000
Sisseton, S. D.	G.	County Bldg.	163	11,200
Braintree, Vt.	G.	Road Impr.	40	1,300
Blanchester, Ohio	L. & G.	Storage tank	195	11,000
Concord, N. H.	L. & G.	Sewers	50	14,000
Three Rivers, Texas	L. & G.	Waterworks Impr.	320	26,000
Louisville, Ky.	L. & G.	School Bldg.,	560	230,000
Granite Falls, N. C.	L. & G.	Sewage	2,500	80,000
Brattleboro, Vt.	G.	Water Mains	38	3,000
Northfield, Minn.	L. & G.	Sewage	300	107,000
Woburn, Mass.	L. & G.	Sewage	900	135,000
St. Albans, Vt.	G.	Street Impr.	20	2,000
Allentown, Pa.	G.	Sewers	250	24,000
Northfield, Vt.	G.	Sewers	245	12,000
Anchorage, Ky.	G.	Waterworks Impr.	60	7,000
Brattleboro, Vt.	G.	Road Impr.	90	4,000
Nobles County, Minn.	G.	Road Impr.	150	8,000
Stillwater, Okla.	G.	Water Mains	15	3,000
Rochester, N. Y.	G.	Buildings	2,400	263,000
Cuyahoga County, Ohio	G.	Road Impr.	150	17,000
Cuyahoga County, Ohio	G.	Road Impr.	600	45,000
Sanitary Dist. of Chicago	L. & G.	Sewers	86,100	33,948,000
		Total:	183,503	$50,770,647

Coast Erosion and Protection Discussed at Washington Meeting

CURRENT requirements in shore and beach protection and the results of research on shore actions were discussed by the American Shore and Beach Preservation Association at its annual meeting in Washington, Dec. 11. At the close of its discussion the meeting passed a resolution urging Congress to enact laws embodying the principle of the use of federal funds for prevention of beach and coast erosion.

After an address by Maj. Gen. E. M. Markham, Chief of Engineers, U. S. Army, expressing the interest of the Engineer Department in shore protection and in scientific research of beach erosion, Lieut. L. H. Hewitt, of the Beard Erosion Board, reported for Col. W. J. Barden, chairman, the results of the board's two years of experimental study of water and sand actions at beaches (see abstract of the interim report of the board, *ENR*, Sept. 7, 1933, p. 281). The board's recommended groin profile and length were emphasized as essential features of secure beach protection structures. Fred Haycox, of Virginia Beach, Va., cited the successful development of beach by a vertical concrete pile and slab seawall without groins at Virginia Beach, where the width of sand deposit has increased by 50 ft. since construction of the wall.

Extended discussion of the respective effects of bulkheads and groins tended to show that results may be distinctly different in different locations. Most of the observations were that bulkhead construction along an eroding beach failed to check erosion, whil groins later added resulted in building beach. It was also reported that the Galveston seawall is now under study by the Beach Erosion Board, as progressive erosion in front of the wall during two decades has removed the beach and exposed the sheetpile base protection of the wall.

Further discussing bulkheads, Victor Gelineau, director of the New Jersey Board of Commerce and Navigation, stated that he has been able to find no case in which a bulkhead caused sand to accumulate except through wind deposition along the top and at the foot of the w ll. In general a bulkhead wall serves only as anchor for the heel of the groins. As to height of jetties, Mr. Gelineau brought out that in an exposed location a groin or jetty may have to serve as breakwater and in this case must be made hig'. and strong. The type of construction used by New Jersey proved its justification in the severe storms of last year, when all state-protected beaches suffered little or no damage while unprotected beaches directly adjacent were in all instances badly damaged.

Construction of an outer bulkhead or offshore breakwater of granite to about 1,000 ft. out from shore at Winthrop, Mass., was reported by Richard K. Hale, of the Massachusetts Department of Public Works. Gen. Hale also referred to the peculiarities of coast structure in Massachusetts, where high walls of gravel as much as 17 ft. high above low water extend along the beach at many points, being formed by the erosion and pushing back of glacial drumlins. Erosion along this coast is not rapid, but upland cutting is active, so that a bulkhead is the first necessity, followed by short jetties of piles and riprap. Piles and wire fences have sometimes been effective. Gen. Hale also emphasized that some beach changes are cyclic, beach building for 10 or 15 years being followed by cutting.

The absence of shore-protection undertakings from the current emergency construction programs as well as from planning studies was discussed in a paper by F. E. Schmitt, editor of *Engineering News-Record*, under the title of Progress in Shore Protection. He made the proposal that the association undertake the systematic observation and compilation of facts relating to shore damage, interests affected, maintenance costs and related facts, in addition to scientific research and engineering and economic studies.

Prof. Thorndike Saville, of New York University, presented an extended survey of the variable coastal erosion and inlet migration along the North Carolina shore, principall at the barrier beaches that form a large part of the state's shore frontage. Prof. Saville emphasized strongly that every beach is a separate problem. The progresive erosion at Wrightsville Beach during the past half dozen years, with failure of groin protection, was fully described.

Col. W. J. Barden spoke briefly of the direction of work of the Beach Erosion Board, and Col. Earl I. Brown suggested that PWA funds be allotted to the board for immediate continuation of its work, now interrupted, as a necessary basis of public-improvement planning.

J. Spencer Smith, president of the Association, presented an address on federal participation in coast-protection problems, which developed convincingly the national interest in shore damage and maintenance.

Winnipeg Plans Interceptors and Sewage Treatment Plant

A sewage-treatment works is planned by the city of Winnipeg, Manitoba, in order to relieve unemployment during the coming year. To this end, the city has retained W. S. Lea, consulting engineer, of Montreal, to prepare plans for a large intercepting sewer and to advise in connection with the first installment of the treatment works. In February of last year, Mr. Lea submitted a report covering the needs of the city and of its six adjacent municipalities in regard to sewage treatment works for 260,000 people initially and 500,000 ultimately. At present crude sewage is discharged through fifty or more outlets scattered along a twenty-mile stretch of the Red and Assiniboine rivers. Mr. Lea recommended the construction of an interceptor seven miles long, designed for future extension upstream, to permit of concentration of sewage from about 70 per cent of the population at a downriver site where ultimately the settleable solids would be removed from all the sewage delivered there, and about half of it subjected to some oxidizing treatment if and when the condition of the river so requires. The estimated cost of the ultimate project to the city is $1,000,000.

Brief News

START OF CONSTRUCTION of the ne Federal Post Office, at Buffalo, N. Y., being delayed by questions of land valu Attorneys for the government have carri to the Circuit Court of Appeals their o jections to payment of $784,700 for the si on the Civic Center, which was held fa and equitable in a lower court.

A TOTAL of 5,329 men were employed o 105 projects in Colorado, by Dec. 2, accor ing to J. A. Elliott, chief engineer for t U. S. Department of Public Roads at De ver, and of more than $6,500,000 allocat to Colorado, $3,338,000 was obligate Heavy snows may stop work on some o the projects, but it is believed that t forces may be used elsewhere.

RECORDS FOR FLOOD CONTROL expendi tures in the Memphis district were broke last month, with disbursements totalli $3,075,155 and representing 21,282 check issued by the district during November The previous high expenditure was $2,945 636, made in 1931 and representing 15,31 checks for one month. More than 13,00 employees, representing a monthly payro of $500,000, were engaged in flood contr activities last month.

PIPELINE CONSTRUCTION is increasing i Oklahoma. The Stanolind Pipe Line C has begun work on its 44-mile 8-in. oil carrier from the new Lucien oil pool o Noble County to the trunk system near Cushing and plans in December to start on a 6-in. line to the gathering system a Paradise, Kansas. In the Perry district o Noble County, 70 men are at work constructing a new 6-in. gas line from the Waltermire gas well to the city of Perry as a supplemental gas source for that city.

A BILL TO PREVENT the city of St. Louis, Mo., from employing outside legal and engineering counsel in proceedings before the Missouri Public Service Commission will be vetoed by the mayor, according to his recent announcement. The mayor indicated that he believed the bill would seriously handicap the city in public utility and rate valuation proceedings, and also prove detrimental in defending lawsuits against the city. Inasmuch as the city charter provides for the employment of such outside counsel, the legality of the bill in any event is open to question.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, Toronto, Ontario, Canada, Feb. 20-22, 1934.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill., March 13-14, 1934.

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention, Chicago, Jan. 22-26, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, Jan. 17-20, 1934.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN TOLL BRIDGE ASSOCIATION will hold its annual convention at Cincinnati, Ohio, Jan. 26-27.

AMERICAN WOOD PRESERVERS ASSOCIATION, Houston, Texas, Jan. 23-25, 1934.

CANADIAN CONSTRUCTION ASSOCIATION, Toronto, Ont., Jan. 22-26, 1934.

ENGINEERING INSTITUTE OF CANADA, 48th annual general meeting, Montreal, Que., Feb. 8-9, 1934.

Personals

D. C. PEACOCK, JR., is now with the Bechtel-Kaiser Co., located at Tucson, Ariz. Mr. Peacock was formerly connected with the Six Companies, Inc., at Boulder Dam.

PUSEY JONES and GEORGE P. STOWITTS, formerly engineer of design and engineer of construction, respectively, for the Cincinnati Union Terminal Co., will be associated in the firm of Stowitts and Jones, consulting engineers, Cincinnati, Ohio.

JOHN L. NEELY, JR., chief office engineer of the Tennessee state highway department, has been appointed coordinator for the TVA by H. A. Morgan. Mr. Neely has obtained leave of absence to take up this work.

LESLIE R. AMES, former state highway engineer of North Carolina, together with S. C. Webb, formerly with the Southern Paving Construction Co., Chattanooga, Tenn., have formed a construction company to be known as Ames and Webb, Inc., with headquarters at Raleigh, N. C.

H. W. CLARK, formerly director of the Lawrence Experiment Station of the Massachusetts Department of Public Health, and also director of the water and sewage laboratory of that department, has opened an office as a consulting engineer on sanitary engineering and sanitary chemistry, at 11 Beacon St., Boston, under the firm name of H. W. Clark, Inc.

HARRY O. WEBER, formerly with the Stone & Webster Engineering Corporation, Boston, and W. MARTIN CLARK, of the galvanized steel division of the Nashville Bridge Co., at Bessemer, Ala., have been appointed structural engineers for the Tennessee Valley Authority on the design of transmission line towers. They will be located at Muscle Shoals, Ala.

JAMES B. WILSON, former chief engineer of the Louisville Water Co., has been appointed city engineer of Louisville, Ky., to succeed A. A. KRIEGER. ROY W. BURKS, Louisville, has been appointed Director of Works, to succeed ARTHUR A. WILL. Both Mr. Wilson and Mr. Burks have served in like capacities in previous city administration.

Obituary

CHARLES A. COWLES, for 46 years chief engineer of the water department of Lynn, Mass., died in that city on Dec. 6. He was born at Lynn 71 years ago.

CHARLES A. BIDWELL, civil engineer of Stockbridge, Mass., and at one time associated with the engineering department of the former Hartford, Providence & Fishkill R.R., died on Dec. 6 at Stockbridge at the age of 91.

HENRY GOTTOLD CHRISTMAN, 64 years old, a general contractor of northern Indiana, died recently at his home in South Bend. Mr. Christman started his contracting business in 1894 and later established additional offices in Detroit and Lansing, Mich.

FLINT MCGREGOR, 49, long prominent as a contractor in Houston, Texas, died Dec. 6, at El Paso, Texas, his recent home. He was closely identified with Houston expansion prior to the world war period. Graduating in engineering from Texas A. and M. College, Mr. McGregor became connected with the office of Stone and Webster at Houston. Later he assisted in the organization of the Central Construction Company, general contractors.

J. A. PATTERSON, 82, pioneer in Canadian railway construction and formerly a well known figure among Canadian and United States railway engineers, died in a hospital in Toronto on Dec. 8. Railway projects in Canada on which he worked are the Credit Valley Ry., Temiskaming & Northern Ontario Ry. and the old Midland Ry. For a time he was a resident of the United States as engineer in the building of the town of Gassaway, W. Va. Later he returned to Canada and was employed for several years on the Canadian National Ry.

CONSTRUCTION STATISTICS OF THE WEEK

GAINS in both private and public construction contracts raised the total of awards this week to $29,454,000, an increase of 25 per cent over the previous week. Private contracts were the heaviest in three months; awards of nearly $4,000,000 for Pennsylvania R.R. rails and $1,400,000 for apartments in Jersey City, raised the total to $9,232,000. Highways and river improvements were strong in the public works field. Road lettings increased for the third successive week, reaching a total of $10,500,000, with nearly every state represented in the list of awards. Two lock contracts on the upper Mississippi were awarded, Lock 8 at Genoa, Wis., going for $1,422,000, and Lock 16 at Quincy, Ill., for $1,468,000. Four more locks in the same district are scheduled for early award.

New capital rose to the highest figure in weeks with $58,466,000 made available for new construction. All but $2,317,000 of this amount represents loans and grants by the PWA.

CONTRACTS
(Thousands of Dollars)

	Weekly Dec. 1932	Average Prev. 4 Weeks	Week Dec. 14, 1933
Federal Government	$6,095	$9,994	$6,939
State and municipal	10,024	14,910	13,283
Total public	$16,119	$24,904	$20,222
Total private	4,553	5,473	9,232
Week's total	$20,672	$30,377	$29,454
Cumulative to date: 1932	$1,177,965	1933	$1,108,718

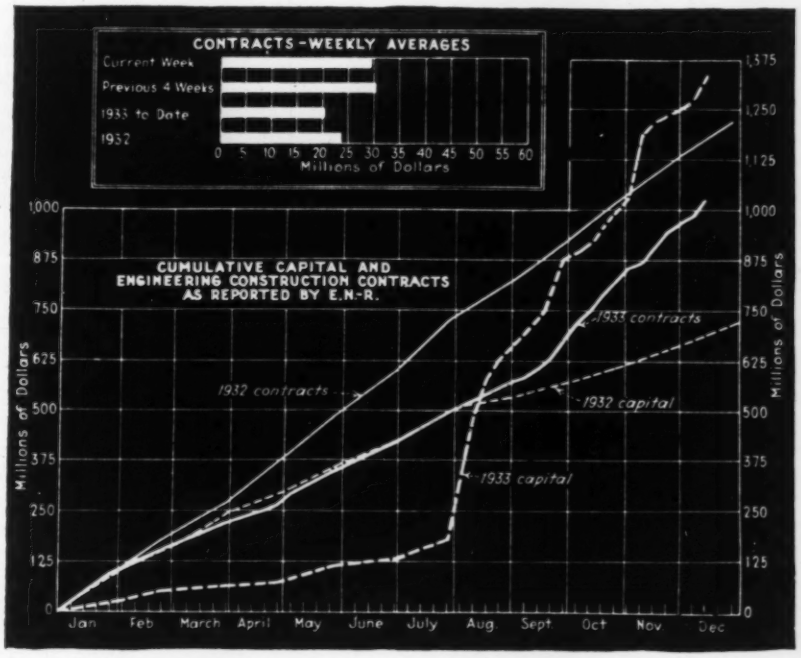
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Week Dec. 14, 1933	Cumulative 1933
State and municipal	$ 2,317	$274,682
PWA allotments, public	50,313	820,532
Corporate issues		50,480
PWA allotments, private	5,836	192,894
Total new capital	$58,466	$1,338,758
Cumulative, 1932		$691,500

Note: These figures include private bonds and stock sold for productive purposes; state and municipal bonds for construction; R.F.C. advances for self-liquidating loans; PWA loans and grants to states and municipalities, including the special highway funds; and PWA private loans.

INDEX NUMBERS

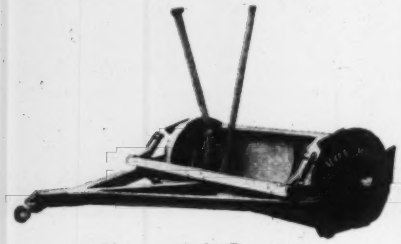
E.N.-R.-Cost		E.N.-R.-Volume	
December, 1933	192.14	November, 1933	133
November, 1933	190.14	October, 1933	162
December, 1932	158.46	November, 1932	137
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)			100



Construction Equipment and Materials

New Scraper of Revolving Type

A new revolving-type scraper has recently been placed on the market by the Davenport Locomotive and Manufacturing Corporation, Davenport, Iowa. The makers state that the new scraper is quick to respond to the control of the tractor operator and is rugged in construction. This ruggedness is attributed to the box-beam construction for the cross member, the steel box beam tongue and heavy channel stiffeners, and a heavy reinforced bowl.



New scraper by Davenport

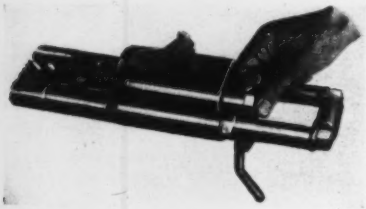
The bottom board and cutting edge of the scraper are made of high carbon steel. A sturdy and positive operating control are provided. The scraper is made in seven sizes ranging from 12 to 56 cu.ft.

Automatic Drill Feeder Depends on Natural Vibration

An automatic feeding device for drifter drills which makes hand cranking unnecessary has been introduced by Ingersoll-Rand Company, New York City.

The auto-feed makes use of no power medium and is completely automatic. It derives its action from the natural tendency of a running drill to creep when the feed screw is allowed to turn in only one direction. The mechanism, which is attached at the end of the feed screw, consists of two ratchet heads, around each of which is a ratchet ring having both internal and external teeth. Pawls on the two ratchet heads are arranged so that depending upon the direction of rotation, the feed screw is locked to one or the other of the rings. This serves to feed the drill either forward or backward, according to which ring is locked. The direction of feed can be reversed by throwing a conveniently located lever. A brake permits retarding the rate of feed or stopping it entirely. When the drill is not running, it can be freely moved in the shell.

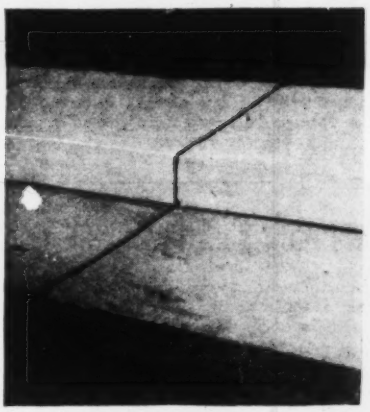
Ingersoll-Rand's new auto-feed for drifter drills



Among the advantages claimed for this auto-feed are: greater overall footage per man shift; better control of the drill in fitchery ground; ease in pulling tightly held steels; ability to operate in close quarters.

New Cork Expansion Joint

A new cork expansion joint has recently been developed by the Johns-Manville Co., New York, which is compressible within itself. According to the manufacturer, it possesses enduring resiliency, is easily compressible under light loads, is not ruptured by heavy loads, is unaffected by freezing and thawing and not softened by high temperatures, and cannot be displaced from the joint space.



Compressible expansion joint of cork

The expansion joint material is made of selected cork particles bound together with a synthetic phenolic resin. Its has all the lasting resiliency of cork wood, and in addition the chemical and structural permanance of a synthetic resin. It is available in any length up to 20 ft., in standard widths up to 12 in., and in various standard thicknesses. Its net weight is about 1½ lb. per board-foot.

Business Notes

AMERICAN MANGANESE STEEL CO., Chicago Heights, Ill., announces that W. K. Leach has been named general manager of the alloy division. Mr. Leach is located at the St. Louis plant of the company. He was formerly with General Alloys Co. of Boston.

THE CONTINENTAL ROLL & STEEL FOUNDRY COMPANY, Chicago, Ill., announces that it has established an industrial equipment division for merchandising heavy tractor operating equipment. The company is now manufacturing and distributing Wooldridge Trailbuilders and Bulldozers.

AMERICAN CYANAMID CO., 535 Fifth Ave., New York City, announces the acquisition of the Filtration Equipment Corp., which owns the Laughlin equipment and process of sewage treatment. Officers of the new corporation are R. C. Jeffcott, president; vice-presidents, W. C. Laughlin, J. T. Fetherston, John W. Boyer; treasurer, C. B. E. Rosane; secretary, W. S. Weeks. The new corporation will continue its headquarters at 350 Madison Ave., New York City.

New Publications

Culverts. Armco Culverts Manufacturers' Association, Middletown, O., have issued a five-page folder on "Soil Conservation." Brief discussion of soil erosion and its prevention by various practical methods utilizing culverts is presented, with photographs of actual installations.

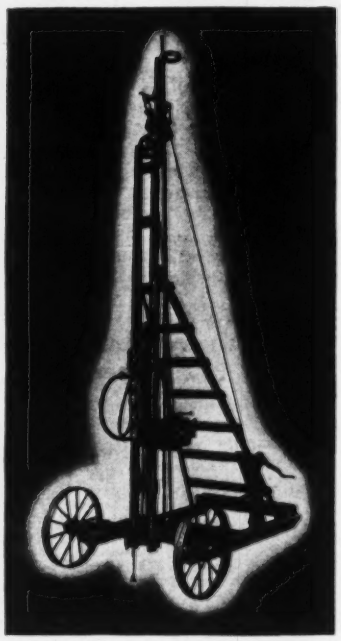
Bulldozer Truck. National Equipment Corporation, Milwaukee, Wis., announce the Koehring Wheel Dumptor in an 11-page catalog which lists the distinctive features of the new device, a combination dump truck and bulldozer. Among these are improvements leading to lower costs, faster operation, reliability, and economy.

Locomotives. The American Locomotive Company have issued a reprint of W. C. Dickerman's address on "Modern Trends in Railway Motive Power," delivered before the New York Railroad Club on April 21, 1933, in a very attractive 48-page booklet. Recent developments and possible future trends in steam, electric, and diesel locomotives are illustrated and discussed.

New Wagon Tool Decreases Net Drilling Time

A new wagon drill, which will handle 3½ in. and 4 in. drills, giving easy spotting of holes in rough ground has been announced by the Gardner-Denver Co., Quincy, Ill.

The wagon is constructed of I-beams, channels and angles. The heavy square axle is offset, carrying the wheels well forward to eliminate the danger of upsetting the outfit when pulling tight steel. The 1-in. cast slide to which the drill is bolted is arranged to take a drill of any size, and the clamps and bolts that hold the drill securely to the slide are completely accessible from the rear by raising the drill. When used with extra long steel, the outfit can be equipped with a hand winch for cable and steel puller, for raising and lowering the steel, and with an extension and guide by which they can be safely handled. A substantial towbar with swiveling wheel makes it easy to move the rig from place to place. Only one string of pipe is necessary for the operation of the drill.



Gardner-Denver wagon drill